UNIVERSITY OF CAPE COAST

PERCEIVED IMPACT OF CONTINUOUS PROFESSIONAL DEVELOPMENT PROGRAMME ON PHYSICS TEACHING AT THE COLLEGES OF EDUCATION IN GHANA

ISAAC SONFUL COFFIE

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BY

ISAAC SONFUL COFFIE

Thesis submitted to the Department of Science Education of the Faculty of Science and Technology Education, College of Education Studies, University of Cape Coast, in partial fulfilment of the requirements for the award of Master of Philosophy degree in Science Education.

JUNE, 2020

DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original research and that no part of it has been presented for another degree in the university or elsewhere.

Candidate's Signature……. Date……

Name: Isaac Sonful Coffie

Supervisors' Declaration

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

Principal Supervisor's Signature……. Date ……

Name: Dr Godwin K. Aboagye

Co-Supervisor's Signature…… Date……..

Name: Dr Eugene A. Johnson

ABSTRACT

The colleges of education in Ghana have been involved in continuous professional development for over four years with support of Transforming Teacher Education and Learning (T-TEL). The main purpose of this research was to assess the perceived impact of the continuous professional development programme on physics teaching at the colleges of education. The study employed a mixed method design specifically concurrent parallel design. An online survey was conducted which was followed by interview with some of the physics tutors. The survey data were analysed using means and standard deviations and ANOVA. Data from the interview were analysed typologically. It was found that the professional development is perceived by the physics tutors to have great impact on their teaching practice as tutors are able to use gender responsive pedagogies and inclusivity strategies to involve students interactively in physics classrooms. It was also found that the commitment of school leadership and support of the professional development team help in the implementation of the professional development ideas. The study however, found that unwillingness of tutors to change, tutors' perception, lack of resources, lack of time and the long period of the professional development are some of the factors thwarting the implementation process. It was therefore recommended effort should be made by the college authorities to provide basics resources like projectors for teaching in the colleges. It was also recommended that there should be an explanation by the T-TEL team to tutors as to why the programme has extended so long and if possible a time that the professional development will end.

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DEDICATION

To my late Mother, Madam Akua Takyiwa and my late father Mr. Isaac Sonful Coffie who did not live long to reap the benefit of their investments. May God grant them eternal rest.

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CHAPTER ONE

INTRODUCTION

Background to the Study

Physics is described as an ancient scientific discipline that studies everything from basic philosophical questions to everyday phenomena, from nature's smallest building blocks to the most distant galaxies, from high-tech satellites to processes in the human body (Angell, Guttersrud, Henriksen, & Isnes, 2014). The study of physics in schools, colleges and universities is therefore very crucial since it is the basis of engineering and technology. Considering the technological age in which we find ourselves in this 21st century, it would be expected that the number of students willing to study physics will increase exponentially. However, reports indicate a sharp reduction of students in physics classrooms (Barmby & Defty, 2006; Galili, 2010; Kranjc, 2010) as too few students opt to study physics (Williams, Stainisstreet, Spall, Boyes & Disckson, 2003). The main factors that account for students' lack of interest in physics have been attributed to teachers (Camarao & Nava, 2017; Ekici, 2016; Sadwoska & Kaminska, 2010).

Physics teachers can have great positive effect on students' understanding and appreciation of the subject (Meltzer, Plisch & Vokos, 2012). However, the teachers themselves have problems in teaching physics (Heras, 2017; Lasry, Finkelstein & Mazur, 2009). They show poor teaching skills and lack of mastery of content (Camarao & Nava, 2017) as Heras asserts that they "follow traditional teaching approaches based heavily on solving standard problems and learning by rote, with no hint of free inquiry or discussion" (p.10). This is supported by Reddish and Steinberg (1999) who

emphasize that physics instructors present physics topics to students without explaining the concepts, skills or attitudes they want students to develop. On his part, Ponchaud (2008) reports that the teaching of physics is characterized by the lack of social context and emphasis on individual response rather than group discussion. Several empirical studies confirm this state of teaching of physics where students describe physics teaching as "boring", "dry", "without innovation", "chalk and talk" (Angell et al., 2014; Buabeng, 2015; Reddish & Steinberg, 1999; Sadwoska & Kaminska, 2010; Williams, et al., 2003). These poor physics instructions do not inspire many students to pursue further study of physics (Meltzer et al., 2012).

The problems with teachers having difficulties in delivering physics could be due to that fact most teachers of physics may not have the needed training. For example, in the USA, it is reported that more than 50% of teachers of high school physics do not have a degree in physics or physics education (America Association of Physics Teachers, [AAPT], 2013). Some of the physics teachers are trained in other sciences, engineering and business disciplines (America Association of Physics Teachers, 2013). The situation is not quite different in Ghana as a study by Buabeng, Ossei-Anto and Ampiah (2012) reveals that some physics teachers' professional qualifications are in project management and journalism. For the physics teachers who have the right qualification, courses and experiences which have the possibility of producing valuable knowledge are not normally available during initial physics teacher education (Meltzer et al., 2012). They add that physics teachers do not have the needed content knowledge and pedagogical preparation for teaching physics effectively. This is supported by a study in

Ghana by Buabeng et al. who concluded that "most of the physics teachers do not have academic qualification and/or certificate in education. What this means is that these teachers may lack the pedagogical knowledge and unfamiliar with the teacher actions that support and promote student learning" (p.48).

A Task Force on Teacher Education in Physics set up by Association of Physics Teachers, and the American Institute of Physics "found that, except for a handful of isolated models of excellence, the professional preparation of physics teachers is largely inefficient, mostly incoherent, and completely unprepared to deal with the current and future needs of the nation's students" (Meltzer et al, 2012, p. vii). A study by Buabeng, Conner and Winter (2016) on physics teachers' view about their initial teacher education (ITE) reports that teachers were not sure that their ITE provided them with the appropriate knowledge of teaching physics. The researchers suggested that the content knowledge teachers acquired from their ITE was not adequate to address the teachers' need.

The solution to the challenges in physics teacher education therefore lies with providing physics teachers with the best learning opportunities through professional development programmes as research and reports indicate that physics teachers acquire more knowledge from such programmes (AAPT, 2013; Meltzer et al., 2012). The America Association of Physics Teachers called on physics teachers to continuously educate themselves as they put it "that being an expect physics teacher requires life-long learning" (p.2). The focus of physics teacher professional development should be towards improving students' learning in the physics classroom.

Guskey (2002) describes Professional Development (PD) as "systematic efforts to bring about change in the classroom practices of teachers, in their attitudes and beliefs, and in the learning outcomes of students" (p.381). Professional development programmes include activities like workshops, courses, and lectures that are designed with the intention of providing teachers with new ideas, skills and competencies needed for improvement in classroom (Fullan, 2007). Luft and Hewson (2014) posit that PD is an on-going learning experience which begins and end with the teachers' career. According to Darling-Hammond and Richardson (2009), for teachers to be able to teach the 21st century skills needed by students, a more effective professional development which is sustainable, job-embedded and collaborative must be provided.

With the changes in the educational sector brought about largely by technology coupled with government reforms, all teachers will require some new knowledge and skills. This is true for experienced educators encountering new concepts of teaching as well as for novice teachers being apprenticed into the profession (National Academies of Sciences, Engineering, and Medicine, 2015). These reforms in education are done with the belief that changes in curriculum would lead to changes in teaching practice. This calls for new ways of teaching with professional development as key driver of such reforms (Wilson & Berne, 1999) that sets school improvement in motion (Soine & Lumpe, 2014). There is a general recognition that professional development is important when it comes to introducing educational reforms (Soine & Lumpe, 2014; van Driel, Meirink, van Veen, & Zwart, 2012; Wilson & Berne, 1999) with Desimone (2009) asserting that teacher learning and for that matter

professional development is one of the most critical target when it comes to educational reforms. This is because educational innovations and reforms demand changes in classroom practices. It therefore stands to reason that attempts to bring innovation and reforms in education are accompanied by professional development programmes (van Driel et al., 2012). Teachers will need a great deal of learning which mostly come in the form of professional development to be to able meet demands expected of them during such reforms. Even though teachers at almost all level of education engage in professional development to improve their classroom practices, research on professional development have concentrated on teachers at the lower levels (especially the elementary levels) of education to the neglect of higher ones (Luft & Hewson, 2014).

Professional development can provide a lot of benefits to the teachers in terms of boosting their confidence, providing them with the opportunity to experience and practice some new skills, and improving their content and pedagogical knowledge. Price and Chiu (2018) assert that professional development is often seen as the key to reforms in teaching and learning. Professional development enhances teachers' effectiveness and bring about improvement in teacher quality thereby improving educational outcome. Kang, Cha and Ha (2013) maintain that teacher professional development can have effect on teachers' learning, teaching practice and student learning. Teacher professional development is very important when it comes to school improvement (Borko, 2004). Most researchers believe that the fundamental purposes of organizing professional development are to enhance teachers' knowledge and classroom practices which will lead to improvement in

students learning outcome (Lohman, 2000; Luft & Hewson, 2014; van Driel et al., 2012).

Of great importance to policy makers, organizers and researchers of professional development is the impact or the effectiveness of the professional development programmes on teachers and students (Guskey, 2000). But for many years, research works on professional development have concentrated on teachers' satisfaction, attitude to change or commitment to innovation to the neglect of the impact of professional development (Desimone, 2011). There is a belief that the more professional development sessions one attends the more efficient he/she becomes. However, the key question that we must ask is how effective is the professional development or what impact did it make? (Stevenson, 2019).

Many researchers have outlined the different characteristics of an effective professional development (Darling-Hamond & McLaughlin, 1995; Wilson & Berne, 1999). However, Desimone (2009) argues that there is now a consensus on the core features of an effective professional development. She identified five characteristics of an effective professional development as content focus, active learning, coherence, duration and collective participation. These core features of effective professional development have been empirically tested by some researchers (Banilower, Heck & Weiss, 2007; Garet, Porter, Desimone, Birman, & Yoon, 2001). According to Borko, (2004) there is evidence that effective professional development activities can help in deepening teachers' knowledge and bring about change in their teaching practice. Opfer and Pedder (2011) however questions why teachers have access to effective professional development but without any change in their

practice. This could be due to the fact that teachers may not get the needed support to carry the ideas presented in professional development as putting a new teaching strategy into practice in the classroom will require support, commitment, effort and time. Guskey (2000) also suggests that some professional developments present ideas that cannot be practicalized because of lack of resources. "Many education reforms rely on teacher learning...so understanding what makes professional development effective is critical to understanding the success or failure of school reform" (Desimone, 2011, p.68).

There are varied goals for organizing professional development programme for teachers (Luft & Hewson, 2014). Some are organized to bring about change in attitudes, beliefs and perceptions of teachers (Guskey, 2000; van Driel et al., 2012). According to Guskey (2000), teachers' perception has influence on professional development implementation, if teachers perceive that the ideas, practices and skills emphasized in professional development are likely to increase their competence and effectiveness, they will accept – and practice them. It is therefore important that teachers' perceptions are considered in studies of professional development as Fullan (2007, p. 129) posits that "educational change depends on what teachers do and think".

Many researchers accept the fact that professional development can bring about improvement in teachers' instructional practices (Borko 2004, Luft & Hewson, 2014; van Driel, et al., 2012). Guskey (2000) asserts that there is now a general recognition about the need to assess how participants apply the knowledge and skills they acquire during professional development programme. He points out that gathering and analysing data about the use or

otherwise of professional development knowledge and how effective they are being applied are important in evaluating professional development programmes. However, it appears this has not been the focus of many research on professional development as reviews indicates that few studies have looked the impact of professional development on teachers' classroom practices (National Academies of Sciences, Engineering, and Medicine, 2015; van Driel et al., 2012). "Professional development is a key to reforms in teaching and learning, making it essential that we use the best practice to measure its effects [on teachers' instruction] (Desimone, 2009, p.192)".

Professional development takes place within a context (school, district, regional and national) which has strong influence on the content, process and outcome (Guskey, 2000). He maintains that contextual factors determine whether professional development will have impact or not. Professional development that work well in one school may not work in another because of different contextual factors. Organizational context is a key variable when it comes implementation of professional development as Borko (2004) states it as one of the key elements of a professional development system. School contextual factors like existing curriculum, principals and colleagues (Opfer & Pedder, 2011) can support or thwart the expected outcome of professional development (Luft & Hewson, 2014; National Academies of Sciences, Engineering, and Medicine, 2015; van Driel, et al., 2012). This is supported by Guskey who indicates that school policies that at variance with professional development practices will thwart implementation effort. While there is the need for a pattern of behaviour at general level, researchers must attend to context specific issues of professional development systems (Opfer & pedder

2011) as there is interaction between the context of professional development and its outcome (Luft & Hewson, 2014). Van Driel, et al. (2012) therefore maintain that contextual issues cannot be ignored in studying the impact of professional development. However, they noted that most studies on professional development neglect the impact of school context on professional development.

The context of the study

A national effort is on-going to transform and upgrade teacher educational programmes in Ghana to produce high quality teachers for the country. The Government of Ghana has aimed at overcoming the poor learning outcomes and identifies teaching both as a hindrance and solution to that progress (Transforming Teacher Education and Learning [T-TEL], 2017). It has therefore instituted a four-year programme called Transforming Teacher Education and Learning (T-TEL) with the financial support of £17 million from the UK government which is aimed at transforming the pre-service teacher education in Ghana by improving the quality of teaching and learning in the country.

> T-TEL seeks to initiate a reform programme to instigate effective professional learning for college tutors and student teachers with the view to developing professional teachers who are well-equipped with knowledge, skills, and the disposition to learn, and who will guide their pupils to achieve the learning outcomes of the national curriculum in basic education. The intended outcome of the programme is the development of beginning teachers who demonstrate interactive, student-focused instructional methods, who demonstrate gender-

> sensitive and student-centred instructional strategies, and who know and can apply the school curriculum and assessment (T-TEL, 2017, p.9).

In view of the reform in teacher education in Ghana, an ongoing Professional Development Session (PDS) have been instituted for the tutors of the colleges of education. The main idea behind the professional development is that an "intervention to improve tutors' teaching skills will lead to changes in the behaviour, performance, and teaching skills of student teachers" (T-TEL, 2017, p.10). This implies that as college tutors learn and adopt interactive and student-centred instructional strategies, the pre-service teachers will also teach using these students-centred approaches as they have experienced in their training. T-TEL provides support for the college based professional development of the tutors. This is a weekly professional development session which is organized in every semester to improve teachers teaching practice. The programme which was started in 2015 has been sustained till now. The professional development has focused on classroom practices -such as questioning, group work, use of teaching and learning materials and many more - which are treated thematically for a semester. But with the recent change in the colleges from the Diploma Awarding to Degree Awarding institutions, another dimensions of the professional development session have been added which are aimed at helping tutors to understand the National Teachers Standards (NTS) and National Teacher Education Curriculum Framework (NTECF) and to also prepare them for the delivery of the 4-year Bachelor of Education (B. Ed) Curriculum. The programme is

organized by specially trained college tutors who are known as professional development coordinators (PDCs).

Statement of the Problem

According to Bill and Melinda Gates Foundation (2014), a whooping sum of $18 billion is spent on teacher professional development annually yet this investment does not yield the expected results. Teachers describe many professional developments they receive as irrelevant, ineffective and having no bearing on their core mandate of helping students learn (Bill & Melinda Gates Foundation, 2014). Policy makers continue to search for evidence of its impact on teachers since so much resources are expended on professional development (Kang, et al., 2013). But not all professional development lead to improvement in the effectiveness of teacher quality (Sione & Lumpe, 2014).

The key question that policy makers must ask is how effective is the professional development or what impact did it make? In most cases, these questions are not asked by the policy makers and "professional learning and development performs an essentially reproductive role rather than offering transformative possibilities" (Stevenson, 2019, p.1). Unfortunately, research on professional development has also not focused much on that as few studies have looked at the impact of professional development on teachers' classroom practices (National Academies of Sciences, Engineering, and Medicine, 2015; van Driel, et al., 2012).

There is an assumption by policymakers that once the necessary organisations are in place, participants in a professional development programme will be able to apply the knowledge which is not always the case

(Guskey, 2000) as contextual factors can influence the outcome of the professional development. However, there exist a gap in professional development studies as most studies neglect the impact of school context on professional development (van Driel et al., 2012).

Since the inception of the professional development for the tutors of the colleges in Ghana in 2015, it appears no study has been conducted to examine the impact the programme on the teaching of physics at the college level. There is, therefore, the need for an in-depth study under this circumstance. This study which looks at the impact of continuous professional development of college tutors will address a major research gap in professional development studies as researches on professional development have concentrated on teachers at the lower levels (especially the elementary levels) of education to the neglect of higher ones (Luft & Hewson 2014).

Purpose of the Study

The main purpose of this research was to assess the impact of continuous professional development programme as perceived by tutors on physics teaching at the colleges of education in Ghana

The specific objectives were to:

1. determine the perceive impact of the professional development on physics tutors' teaching.
2. determine how the physics tutors perceive the impact of the professional development on their knowledge about the national teachers' standard and the national teacher education curriculum framework.

3. determine the perceived impact of the professional development on tutors' knowledge about the 4-year bachelor of education curriculum.
4. identify what factors affect physics tutors use of the ideas acquired in professional development.
5. find out if differences exist in the perceived impact of the profession development by the physics teachers based on their qualification.
6. find out if differences exist in the perceived impact of the profession development by the physics teachers based on their teaching experience.

Research Questions

The research was guided by the following questions

1. What is the perceived impact of the professional development on physics tutors' teaching practice?
2. What is the perceived impact of the professional development on physics tutors' knowledge about the National Teachers Standards and National Teacher Education Curriculum Framework?
3. What is the perceived impact of the professional development on physics tutors' knowledge about the 4-year Bachelor of education curriculum?
4. What factors affect physics tutor's use of the ideas acquired in the professional development?

Hypotheses

These hypotheses were also formulated and tested at .05 level of significance:

1. There is no statistically significant difference in the perceived impact of the professional development by the physics teachers based on their qualification.
2. There is no statistically significant difference in the perceived impact of the professional development by the physics teachers based on their teaching experience.

Significance of the Study

The study would be beneficial to policy makers especially T-TEL on the success or otherwise of the professional developments which have been instituted as part of the reforms in teacher education in Ghana. New practices are likely to be abandoned if there are no evidence of its impact. Hence, a way of providing feedback on the impact are critical for the realisation of any professional development effort (Guskey, 2002). The results from the study would therefore serve as guide for physics teachers as to how best they are putting their professional knowledge in practice.

Delimitations

The study was delimited in scope to cover physics tutors who teach elective or core physics in the public colleges of education in Ghana. Tutors may be involved in many professional development programmes but this study specifically targeted the continuous professional development organized by T-TEL.

Limitations

The data used in the study is cross-sectional in nature in which alternative causal impact cannot be ruled out. Also, it was based on teachers' self-report so the results may not represent the actual practice as teachers could exaggerate the impact of the professional development.

Definition of Terms

Continuous Professional Development: A special professional development programme that has been instituted at the colleges of education to enhance the knowledge and practice of tutors

Professional development session: A weekly meeting times where the professional development programme is organised.

Physics tutor/teacher: Used interchangeably to refer to a teacher at the college of education who teaches either elective physics or core physics.

List of Abbreviations

CPD: Continuous professional development

PD: Professional development

PDCs: Professional development coordinators.

T-TEL: Transforming Teacher Education and Learning.

NTS: National Teaching Standard.

NTECF: National Teacher Education Curriculum Framework.

Organisation of the Study

The research report was organised into five chapters. The first chapter which is an introduction of the study covered the background to the study, statement of the problem, purpose of the study, research questions, the

significance of the study, the delimitation of the study, limitations of the study, and definition of terms.

The second chapter reviewed literature related to the study. It covered the theoretical and conceptual frameworks together with the review of related empirical studies. Chapter three of the study focused on the methods for the study which covered the research design, the population, the sampling procedures, the instrument used, data collection procedure and the data processing and analysis.

The fourth chapter presented and discussed the results of the study. The fifth and final chapter provided the summary, conclusions and recommendations of the study.

CHAPTER TWO

LITERATURE REVIEW

The study seeks to assess the impact of continuous professional development programme on the teaching of physics at the colleges of education in Ghana. This chapter of the study reviewed related literature on the topic by synthesising and criticising both theoretical and empirical literature related to the work so as to ascertain their implications for the development of my own study. The review covers the following subheadings:

1. theoretical framework,
2. professional development: meaning and importance,
3. features of effective professional development,
4. impact of professional development,
5. contextual factors affecting professional development,
6. professional development and teachers' background characteristics
7. summary of the review,
8. conceptual framework.

Theoretical Framework

According to Kang et al. (2013), a framework to be used in evaluating the impact of PD should consider three key issues. It should identify what constitute an effective professional development, explain how it affect teachers' practices and student outcomes and then describe the contextual factors that can affect professional development. Such a theory would identify the main inputs, the outcomes (immediate and final one) that define the impact of professional development and also identifies the variables that interact in the model (Desimone, 2009).

Based on this, the theory used for this study is "The Path Model," a theoretical model proposed by Desimone (2009) for studying professional development. "The model represents interactive, nonrecursive relationships between the critical features of professional development, teacher knowledge and beliefs, classroom practice, and student outcomes" (Desimone, 2009, p.184). It is based on extensive review and synthesis of literature and therefore has strong theoretical and empirical basis.

The path model explains the relationships among the key variables in professional development such as features of an effective professional development, change in teacher knowledge and instruction. The path model is focused on four steps: 1) teachers need to experience high- quality professional development; 2) professional development increases teachers' knowledge and changes their attitudes or beliefs; 3) teachers' new knowledge, attitudes, and beliefs can change teaching practice; and 4) instructional changes increase student learning. As teachers experience the professional development, it enhances their knowledge and skills and/or results in changes in their attitudes and beliefs, the application of which leads to improvement in instructional content, pedagogical approach or both. The instructional changes then bring about an improvement in student learning outcomes.

The model enables researchers to test how professional development changes teachers' beliefs, knowledge or practices and how that changes affect students' learning outcomes. The main reason for choosing this model is that apart from it comprehensiveness in addressing professional development issues, it also allows for more moderating or mediating elements such as teacher identity, beliefs, perception and many others (Desimone, 2009). The

model is relevant to this study because, it describes the paths of impact of effective professional development from teachers to students and how contextual factors affect that impact which are the issues of consideration in this study.

Professional Development: Meaning and Importance

Guskey (2000) describes professional development as activities designed to enhance the professional knowledge, skills and attitudes of teachers so that they might in turn improve the learning outcome of students. To Luft and Hewson (2014), professional development is purposefully designed learning opportunity that comes after the teachers' initial preparation. National Academy of Sciences, Engineering and Medicine (2015) also describes professional development as formally organized programmes with teacher learning experiences that;

i. are intentionally designed to bring about a kind of teacher change.
ii. takes place outside the teachers' classroom or the school.
iii. is time bound.

Professional development system is made up of four key elements; the professional development programme, the teachers, the facilitators and the context (Borko, 2004).

To Desimone (2009), what might be considered as professional development is cast wide in literature. But Garet et al., (2001) believe all professional developments can be classified into two based on the type of the activity involved in the program. We can have the traditional form of professional development which include programmes like workshop, conferences and courses. These professional development programmes reduce

teachers to mere spectators (Ingvarson, Meiers, & Beavis, 2005). The traditional form of professional development mostly take place outside of teachers' school or classroom which is attended by expert and participants who are the teachers. These traditional form of professional development are the mostly criticized form of professional development in literature (Garet et al., 2001).

As a result of the criticism, there is shift toward "reform" types of professional development such as study groups, mentoring and coaching (Garet et al., 2001). These reform types of professional development are complex and broad-based (Desimone, 2009) and take place within the regular school days and even within classroom instructions. Professional development is now considered as job embedded, linked directly to the teachers work in an individual or social form. Garet et al. (2001) argue that because these reform professional developments are located within the teachers' regular work day, teachers are more likely to connect the ideas in their classroom instruction than the traditional type.

Educational reforms and school improvement programmes demand professional development. This is because there is rapid growth of knowledge in all fields of education which requires new expertise so that teachers can be abreast with emerging knowledge. Also reforms in education demands that teachers and administrators change their role and take on new responsibilities. Professional development is therefore needed by teachers and administrators so that they can learn these new roles and perform well (Guskey, 2000). Professional development plays a very instrumental role in closing the gap between teacher preparation and standard based reforms. It is a key focus for

educational improvement (Birdman, Desimone, Porter & Garet, 2000). Many institutions therefore spend a lot of resources in providing professional development as a means of ensuring that teaching is consistent with the school's vision (Klein & Riordan, 2009).

Most professional development activities are organized with the aim of enhancing teacher knowledge and improving classroom practice (Ingvarson et al., 2005). Professional development is now considered as an important part of efforts to bring about improvement in quality of teaching and learning in schools (Ingvarson et al., 2005). Professional development holds the keys to improving teaching and learning of science (Supovitz & Turner, 2000) and are designed as part of reforms efforts with the aim of implementing innovations in science education (van Driel et al., 2012). There is therefore the need for science teachers to receive adequate professional development in order to improve their knowledge and teaching practice (Luft & Hewson, 2014).

Despite the importance of professional development, there are those who see the increased demand for professional development as an indication of deficiencies in the knowledge and skills of teachers. The emphasis on professional development does not indicate deficiencies in knowledge but a recognition of the fact that education is a dynamic professional field (Guskey 2000). Guskey posits that professional development is considered by many teachers as having little impact on their work. It is regarded by some teachers as a waste of time as it has not always yielded the expected results (van Driel et al., 2012) but they do attend it to satisfy 'contractual obligations' (Guskey, 2000). Despite this view, professional development is the key for teachers to

keep up with the increasing knowledge in the field of science and technology. Policy makers believe that when science teachers are provided with the necessary learning opportunities they will be able to prepare their students for the 21st century (Luft & Hewson, 2012).

Features of Effective Professional Development

Mizell (2010) describes effective professional development as one which focuses on the information and skills teachers need to address students' learning difficulties. An attempt to define what constitute an effective professional development has resulted in various researchers producing a list of essential characteristics of an effective professional development some of which are based on the analysis of literature on professional development (Desimone 2009; Ingvarson et al., 2005; Supovitz & Turner, 2000; Wilson & Berne, 1999). The reason for relying on different list of characteristics of professional development is that there is no single predominant theory about teacher learning. Teaching is conceived in different ways and therefore there are different ideas about how professional development can improve it (Kennedy, 2016)

Desimone (2009) argues that is now a consensus on the features of an effective professional development as she puts it that "given the number, quality, and diversity of studies that provide support for the features, I conclude that we have reached a consensus that these core features play an important role in determining the effectiveness of professional development" (p. 183). There is empirical agreement on the key features of professional development which is related to changes in knowledge, practice and to some extent, student achievement. Desimone (2009) identified the key features of an

effective professional development to be; content focus, active learning, coherence, duration and collective participation. In their review of current state of professional development in science education, van Driel et al., (2012) identified school organisational conditions as another core features of an effective professional development.

However, Desimone, Porter, Garet, Yoon, and Birdman (2002) hypothesized that six features of professional development are effective in improving teaching practices. These features have been classified into "structural feature" which deal with nature of the professional development activity and covers the reform type, duration, collective participation and "core features" which also deal with the "substance of activity" covers active learning, coherence, and content focus (Birdman et al., 2000; Desimone et al., 2002). Desimone et al. (2002) however noted that these six features of professional development are not the only features of effective professional development.

These key features of effective professional development have been empirically tested by some researchers (Birdman et al., 2000; Garet et al., 2001; Ingvarson, et al., 2005; Penuel, Fishman, Yamaguchi & Gallagher, 2007) to show that many of such characteristics of professional development are essential for impacting changes in teachers' classroom practices and supporting student learning (Desimone et al., 2002; Garet et al., 2001). These studies which were conducted to find the effectiveness of science and mathematics professional development found that teachers who take part in professional development that was coherent, involved active learning and

emphasized content knowledge indicated an enhancement in their knowledge and changes in their teaching practice

According to van Driel et al. (2012) these characteristics must be seen in any professional development program however their presence alone is not enough to indicate the effectiveness of the professional development. Kennedy (2016) from a review of professional development argues that the design feature may not be a reliable predictor of the success of a professional development programme. She asserts that we need to change from our thinking that professional development that is effective is based on particular design features to "a conception that is based on more nuanced understanding of what teachers do, what motivates them, and how they learn and grow" (p.30).

However, there has been an increase research that focus on what constitute an effective professional development (Penuel et al., 2007). This is because effective professional programmes offer teachers the chance to implement and reflect on the new instructional practice, analyze student thinking and work, and to analyze examples of such instructional practices (National Academy of Sciences, Engineering and Medicine, 2015). But measuring the effectiveness of professional development is very a difficult challenge because of the range of experiences that are considered as professional development (Desimone, 2011).

Luft and Hewson (2014) believe that science professional development programs possess unique requirement. Using content, context and process as the basis for such belief, they failed to provide a real proof of how these characteristics are different from other professional development in general.

According to Guskey (2002) the following principles are important in planning effective professional development.

1. Change is a gradual and difficult process for teachers
2. Ensure that teachers receive regular feedback on student learning progress. If teachers perceive professional development as increasing their competence and effectiveness, they will practice it.
3. Provide continued follow-up, support and pressure.

There is a mixture of high and low quality professional development as experience by teachers with the number of teachers experiencing all the six features of an effective professional development being very small. The reason why few professional developments have these qualities is that such programmes are costly. Also the provision of such programmes are challenging and requires good timing and planning (Birdman et al., 2000). Garet et al. (2001) found that a lot professional development programmes whether it is reform or traditional lack the characteristics of high quality expected in professional development. The reasons are that such activities are costly to provide and it also challenging to provide since they demand a lot of "lead time and planning". Garet et al. suggested that in order to produce high quality professional development that can impact on teaching practice, professional development providers should either concentrate on fewer teachers or put in more resources. Desimone (2009) identified the key features of an effective professional development to be; content focus, active learning, coherence, duration and collective participation.

Content focus

The content of professional development refers to the topics that are taught in a professional development programme (Garet et al., 2001; Kennedy, 1998). Desimone (2011) believed content is the most important feature of professional development while Jeanpierre, Oberhauser and Freeman (2005) claims that the selection of content is the most crucial decision making in the planning of a professional development programme. The content can include classroom management and discipline techniques, techniques for working with parents, legal definitions of sexual harassment, knowledge about specific school subject matter, knowledge about how students learn specific school subject matter, knowledge of how to teach specific school subject matter (Jeanpierre et al., 2005, Kennedy, 1998). Garet et al. (2001) identified four dimensional variations along which content in professional development covers. These variations are on subject matter, teaching practice, goal of student learning and ways student are to learn a particular subject matter.

Professional development that generally focus on teaching techniques without focus on content are ineffective (Birdman et al., 2000). Desimone (2009) therefore advocates that professional development activities must concentrate on subject matter knowledge and the way students learn that content. Teachers need specific subject matter knowledge and knowledge about how children learn the subject matter and professional development that account for these issues could have great impact (Kennedy, 1998). This idea also supported by van Driel et al. (2012) who argue that for professional development to be effective, then it should focus on pedagogical content knowledge and learning processes of students in specific subject matter. It

must also focus on current and research-based knowledge of teaching and learning. This content focused professional development targets specific subject area or subject specific teaching method by avoiding general teaching methods such grouping methods (Birdman et al., 2000). According to Borko (2004) professional development activities that focus on subject matter knowledge can help the teachers in gaining understanding which can improve classroom teaching.

From a review of professional development, Kennedy (2016) suggested that professional development that concentrated solely on content knowledge was effective especially on students' learning. Cohen and Hill (2000) and Kennedy (1998) identified that professional development programmes are more likely to have an impact students' learning if the program focuses on subject matter knowledge and student learning. Kennedy (1998) noted from a review of studies on in-service professional development programmes which focuses on enhancing mathematics and science teaching that "programs that focus on subject matter knowledge and on student learning of particular subject matter are likely to have larger positive effects on student learning than are programs that focus mainly on teaching behaviours" (p.9). Enhancing science content knowledge supports positive change in teachers' classroom practices (Garet et al., 2001; Jeanpierre et al., 2005). Garet et al. (2001) found a negative correlation between content focus and change in teaching practice when the activity does not increase teacher knowledge.

Several empirical studies suggest that content-focused professional development can influence teachers' knowledge, teaching practice, or student learning (Cohen & Hill, 2000; Desimone et al., 2002; Garet et al., 2001;

Ingvarson et al., 2005; Penuel et al., 2007). Cohen and Hill (2000) conducted a study to examine the influence of assessment, curriculum, and professional development on teacher practice and student achievement. Using data from a 1994 survey of California elementary school teachers and 1994 student California Learning Assessment System (CLAS) scores, the researchers found that the content of professional development teachers engaged in made an impact on their teaching practice. Cohen and Hill argued that even if a large amount of time is spend on a professional development that focuses less on content, it will not yield the expected results. They argue further that teacher professional development that makes meaningful impact must even go beyond "subject specificity" to even to topic "specific learning opportunities."

Active participation

Active participation has to do with activities teachers engage in during professional development session (van Driel et al., 2012). This feature of professional development relates to the chance provided in the professional development activity for teachers to be keenly engaged in meaningful discussion, planning and practice (Garet et al., 2001). For any effective professional development activities, opportunity must be given to teachers to engage in active learning through observing and receiving feedback; analyzing student work; making presentations; making connection between their learning and classroom instruction; reading and writing; planning for classroom implementation; (Birdman et al., 2000; Desimone 2009, Desimone 2011, Garet et al., 2001; Penuel et al., 2007; van Driel et al., 2012).

Activities that engages teachers as active learners make professional development effective (Borko, 2004) enabling teachers to relate the

professional development to their classroom practice (van Driel et al., 2012). Active participation in professional development allows teachers to discussion issues such as concepts and problems pertaining to the professional development. It provides opportunity for teachers to integrate the ideas learn in professional development with teaching practice (Birdman et al., 2000). Supovitz and Turner (2000) noted "that this feature is having a pervasive and generative influence on factors that increase teachers' confidence and ability to meet student needs" (p. 14). Studies have shown a positive relationship between active studies in professional development and teachers' knowledge or teaching practice (Desimone et al., 2002; Ingvarson et al., 2005).

In a study to examine the effect of professional development programmes on teacher knowledge, practice and efficacy, Ingvarson, et al. (2005) surveyed 3250 teachers who were involved in eighty individual professional developments. Participants were asked to describe professional development they had experience and impact the programmes had made on their knowledge, practice, sense of efficacy and their student learning. The study was based on a report evaluation studies taken by the Australian Government Quality Teacher Programme (AGQTP) aimed at improving teaching skills. Using blockwise regression analysis, the study found that the extent to which the program focused on content influenced the impact on knowledge.

Also a study by Supovitz and Turner (2000) indicated a significant relationship between active learning and impact on instructional practice and teacher efficacy. The result is similar to Garet et al. (2001) study who found that professional development that focus on content and active learning had

significant impact on teachers' knowledge and instructional practice (Desimone, 2002).

There is a positive relationship between active learning in professional development and the use of the practices in classroom. This implies that if professional development engages teachers in active learning they are likely to practice the activity in their classroom. This is supported by a study conducted in the USA by Sione and Lumpe, (2014) whose purpose was to create an instrument for measuring teachers' perception of characteristics of professional development. It was found that there was significant correlation between Active Learning and teachers' use of new knowledge and skills.

Coherence

This feature of professional development deals with the degree to professional development activities are be consistent with; other professional development (this is because professional development programmes are often criticized for not connecting with one another); teachers' knowledge and beliefs; school, district and state reforms and policies like assessment (Birdman et al., 2000; Desimone, 2011). Many researchers consider coherency in professional development in terms of the way it is understood by teachers to be part of a consistent programme of their own learning and that of their students (Garet et al., 2001; Penuel et al., 2007).

Reforms in education bring about different roles for teachers than have been usual in their classrooms. Therefore, teachers' views of themselves must be aligned with their expected roles (Heck, Banilower, Weiss, & Rosenberg, 2008). A professional development programme is more likely to make an impact on improving teachers' knowledge and skills if it forms a consistent

part of a wider set of opportunities for teacher learning and development (Birdman et al., 2000; Garet et al., 2001).

A study was conducted by Penuel et al. (2007) using 454 teachers who undertook a professional development aimed at preparing them to implement materials from an international earth science programme. The purpose of the study was to examine the effects of different characteristics of professional development on teachers' knowledge and their ability to implement the programme. Data were analysed using Hierarchical Linear Modelling (HLM) framework. It was found that coherence was a significant predictor of teacher change and pedagogical knowledge. Garet et al. (2001) in their study found that coherency in professional development is positively related to teaching practice suggesting that teachers who experience coherent professional development are more likely to change their instructional practice.

Duration

Duration is the most consistently reported feature of an effective professional development but the most difficult element to specify since studies of varying time of participation have been found to be effective (National Academy of Sciences, Engineering and Medicine, 2015). Even though there is no agreement on the exact duration of professional development that is effective (National Academy of Sciences, Engineering and Medicine, 2015), but support is given to professional development activities that spread over semester and include 20 hours or more of contact time (Desimone, 2011). Supovitz and Turner (2000) showed that change in teaching practice occurred after 80 hours of professional development. Similar result was obtained by Heck et al. (2008) who found a positive relation

between teachers' perception of their pedagogical preparedness and hour of professional development where observed gained occurred within the first 100 hours of professional development. The effect of professional development on teaching practices can dramatically emerge when the experiences are deeper and more sustained (Supovitz & Turner, 2000).

Professional development programmes have been criticized for their short duration (Penuel et al., 2007). An effective professional development activity that can bring about an intellectual and pedagogical change must have enough time (Desimone, 2009). The lack of impact of professional development has been attributed to the shortness in intensity and length of these programmes (Supovitz & Turner, 2000). However, Kennedy (1998) believed duration is not the most predictor of impact of professional development. From her review of PD Kennedy, (2016) found that programme duration has more impact on professional development when the programme provides strategies or insights. It means that the contribution of professional development programme duration to its effectiveness is dependent on other key features of the programmes (National Academy of Sciences, Engineering and Medicine, 2015). Duration can therefore be considered as proxy factor because how effective professional development can be dependent on the context, teacher prior knowledge and skill, the type of knowledge to be acquired and the network in which the teacher belongs to (National Academy of Sciences, Engineering and Medicine, 2015).

According to Garet et al., (2001), recent literature on professional development advocates for professional development that is sustained over long period of time. Garet et al claim that, "professional development is likely

to be of higher quality if it is both sustained over time and involves a substantial number of hours" (p. 933). However, in a study by Desimone et al. (2002), the result indicated that duration (contact hour and span) showed no effect on teaching practice after professional development. Also study has shown a negative correlation between the total hour of professional development and teachers use of the practices emphasized in the programme (Penuel et al., 2007).

To Garet et al. (2001), duration of professional development is important for two main reasons. Professional development with long duration present a chance to do a detailed discussion of content. It also will enable teachers to try out new practices in classrooms and receive feedback on the implementation thus given opportunities for detailed study, "interaction and reflection" (Garet et al., 2001). However, Kennedy (1998) argues that the longer the period of professional development, the more likely that other factors could influence the outcome. She further argues that long period of professional development could cause teachers to lose interest in the programme. She therefore concluded that the argument for more contact hours in professional development is not supported by her review. But in a study conducted by Garet et al. (2001,) the researchers concluded that professional development is likely to be of high quality if it has long duration.

Collective participation

There is emerging interest in professional development that is collaborative in nature (Garet et al., 2001), as groups of teachers from the same grade, subject, or school engage in professional development activities together (Desimone, 2011). Van Driel et al. (2012) emphasize the need for

collaborations among teachers from the same grade, subject or school since collaboration is needed in supporting teachers' instructional change (Garet et al., 2001).

Professional development that is collaborative provides teachers with the chance to discuss concepts, skills and problems that they may encounter during professional development experience (Garet et al., 2001). Where there is collaboration among teachers, they reinforce, construct, increase and challenge their notion about the teaching of science (Luft & Hewson, 2014). Teachers who teach students' from the same department or grade can discuss students learning difficulties across the classes and grade levels (Garet et al., 2001) enabling them to build an interactive learning community (Desimone, 2011). There are empirical researches to support that professional developments that are collaborative in nature can be effective in changing teaching practice (Desimone et al., 2002; Penuel et al., 2007).

A significant relationship was found between the level of professional community (sharing of ideas, collaboration among teachers, support for each other) and the impact on teachers' knowledge and practice (Supovitz & Turner, 2000). Southerland et al. (2016) conducted a longitudinal study to examine the change in the thinking and practices of teachers after participating in two professional development using 106 teachers. Using data from questionnaire, interview and observation the researchers found that some feature of professional development, specifically high collaboration, influenced the teachers' thinking and practice.

Impact of Professional Development

The impact of professional development programmes to the science teacher leads to the following outcomes; teacher ability to adopt teaching to the needs of different students, increase content knowledge and pedagogical content knowledge and improvement in instructional practice (National Academy of Sciences, Engineering and Medicine, 2015). Teacher professional development can have effect on teachers' learning, teaching practice and student learning (Kang et al, 2013). The impact of any professional development depend on how well motivated the teachers are to learn and change their practice. If teachers are not motivated they will not resist the programme but they will forget about the ideas learnt in professional development when they go back to their classrooms (Kennedy, 2016).

According to Bill and Melinda Gates Foundation (2014), teachers describe many professional developments they receive as irrelevant, ineffective and having no bearing on their core mandate of helping students learn. Some of reasons why professional development is considered ineffective are that some professional developments present ideas that cannot be practicalized because of lack of resources and some are not well planned or supported (Guskey, 2000).

A survey conducted by the Bill and Melinda Gate Foundation (2014) on implementing effective professional development involving 1,300 teachers and other stakeholders of education revealed that there is a disconnect between the professional learning that decision makers intend and what teachers actually experience. It was shown that only 29% of the teachers are satisfied with the professional development currently being offered with majority of the

teachers believing the professional development is not helping them to prepare for the changing nature of their job including using technology and digital learning tools. The study also found that professional development provided by educational leadership are not meeting the needs of the teachers.

Various researchers have looked at the impact of professional development on teachers and have shown a positive relationship between features of a professional development and teachers' classroom practices emphasized in the professional development (Price & Chiu, 2018; Ingvarson et al., 2005).

Impact of Professional Development on Teachers' Knowledge and Skills

According to van Driel et al. (2012), professional development can have an effect on teacher's cognitions (i.e. their knowledge, beliefs and attitudes). Most professional development programmes are designed to enhance teachers' knowledge and classroom practices. Guskey (2002) posits that "what attracts teachers to professional development, therefore, is their belief that it will expand their knowledge and skills, contribute to their growth, and enhance their effectiveness with students" (p.382). Professional development in science can produce positive and lasting changes in teachers' knowledge and beliefs and instruction (National Academy of Sciences, Engineering and Medicine, 2015). Studies show a positive relationship between professional development and teachers' knowledge and skills (Banilower et al., 2007; Heck et al., 2008; Penuel et al., 2007).

In an experimental study of science teachers' professional development programme involving 125 teachers and 1676 students, Price and Chiu (2018)

found that teachers in the experimental gained 7% content knowledge than their counterparts in the control group.

Heck et al., (2008) and Banilower et al., (2007) investigated the relationships between professional development and teachers' attitudes and teachers' knowledge. They used teachers' self-reported survey data to measure the relations. Using Hierarchical Linear Modelling (HLM), the researchers found that the total number of hours the teachers spent participating in National Science Foundation's Local Systematic Change (LSC) projects was directly related to their attitudes towards both standards-based teaching and their perceptions of pedagogical and content preparedness.

Penuel et al. (2007) examined the relationship between professional development and teachers' knowledge. They defined teachers' knowledge as teachers' knowledge of pedagogy, which includes both content knowledge and pedagogical content knowledge. They used teachers' self-reported survey data to measure this knowledge. Using Hierarchical Linear Modelling (HLM), the results showed that teachers' perceived coherence of earth science education programs had a positive correlation with their pedagogical knowledge.

Impact of Professional Development on Instruction Practices

Professional development can affect teachers' behaviour which will manifest in their classroom practices (van Driel et al., 2012). Teachers' opportunities to learn about reform influence their knowledge and practice. This effect is what Clarke and Hollingsworth (2002) referred to as "domain of practice". Professional development is regarded as an important means of changing teachers thinking and increasing their content knowledge which in turn influence and improve their classroom practices (Borko, 2004; Desimone

et al., 2002; Southerland et al., 2016). Professional development thus improves teachers' pedagogical content knowledge.

Given the major role teachers play in educational reforms, it is very important that professional development provides the teachers with the needed content and opportunities to bring about changes in their teaching practice (Birdman et al., 2000) since professional development is seen as the best bet for effecting change in teachers' practices (Supovitz & Turner, 2000).

It is generally accepted that professional development can bring about improvement in teaching practice (Kennedy, 2016). But for that to occur Southerland et al. (2016) claim that there must be a balance between teachers' "pedagogical discontentment" (ie the degree to which teachers are dissatisfied with their teaching practice and want to change) and their self-efficacy. This means that until teachers are dissatisfied with their teaching practice and have the belief that it can be changed, there will not be any change in their teaching practice. This idea is supported by Gess-Newsome, Southerland, Johnston and Woodbury (2003) who argued that removing contextual barrier is a necessary but not a sufficient condition to bring change in teachers' practices. They further argued that for change in teaching practice to take place there should be existence of pedagogical dissatisfaction. "We must focus on teachers' dissatisfaction with their current practices and their degree of engagement with existing reforms if we are to understand the manner in which they enact reforms" (Gess-Newsome et al., 2003, p.738).

For teachers, carrying out a new idea or practice is finding out how and when to add that idea into their already developed habitual practices (Kennedy

2016). According to Doyle and Ponder as cited in (van Driel et al., 2012) teachers consider innovation such as new teaching practices as practical when;

a. efficient procedures are available to translate innovative ideas into concrete instruction;
b. the change in proposal fits their current practice and goals sufficiently;
c. implementation of the innovation will require limited investment, whereas the expected benefits are substantial. Implementation of such innovation becomes difficult if it does not meet these practicality criteria,

According to Guskey (2000), there are components of professional development that are linked to increased use of new instructional practices. These components include;

a. engaging teachers with content knowledge directly relevant to what students are learning
b. providing follow-up and support in implementing new skills
c. developing an understanding of the rationale behind the new skills
d. using peer study groups to learn about new skills.
e. demonstrating the new skills live or through videotaped session.

Trying to change the teaching practices of teachers is a very difficult task to achieve because the process requires concerted efforts (Johnson, 2007). Luft and Hewson (2014) therefore suggested that teachers need different forms of instructional support in order to change their instruction. This instructional support require collaboration from peers and educational communities (Wilson & Berne, 1999). Changes in teaching practices demand time for 'adaptation adjustment and refinement." Better results are obtained for changes in

instructional practices during the second year of implementation as there will be refinement and efficiency of effort while the first year will be for experimentation (Guskey, 2000). There are a lot of empirical evidence to support the fact that professional can influence teachers' classroom practices.

In an experimental study of science teachers' professional development programme, involving 125 teachers and 1676 students, Price and Chiu (2018) found that there was an effect on the teachers in their classroom practices as teachers in the treatment engaged in more student-centered teaching activities than those in the control group. A study was conducted by Rauf, Ali and Noor (2017) involving 1180 teachers to examine the relation between professional development and teacher classroom practices. The researchers found a positive relationship between professional development and teachers' instructional practices.

A survey was conducted by T-TEL (2017) to assess the impact of T-TEL programmes in the colleges of education. Using teachers self-report and observation, it was found that the 65.9% of tutors used in the study demonstrated student-focused teaching methods compared to a previous baseline study of 26.1%. It was concluded that "a growing number of tutors have mastered the use of student-focused teaching methods and gender-responsive instructional strategies" (T-TEL, 2017, p.38).

Southerland et al. (2016) conducted a longitudinal study to examine the change in the thinking and practices of teachers after participating in two professional development using 106 teachers. Using data from questionnaire, interview and observation, it was found that changing teachers' beliefs about teaching had an indirect influence on teachers' instructional practices. That is,

teachers' participation in the professional development influenced their belief which in turn affected their teaching practice.

A qualitative research was conducted by Klein and Riordan (2009) to study eight teachers from New York City who participated in a professional development on the use of expedition in teaching. The researchers used interview and observation in the data collection process. Analysis of the data showed that the teaching practice of the teachers after the professional development was within a "continuum of implementation" starting from no "rejection to full adaption". Klein and Riordan found that some teachers indicated in the interview that they use the professional development practices but the observation of their lessons indicated otherwise. This implementation was referred to as token implementation by the researchers. The researchers also found an implementation style which they term as "mistaken implementation" where some of the teachers merged old and reform practices together making the professional development practices ineffective. This the researchers attributed to the organizers of professional development for not indicating the extent of adaption to which it will not represent the original ideas espoused in the professional development. Direct implementation was a situation where teachers implemented professional development practices in their classroom in the same manner as they experience it. This was usually the beginning point for teacher's implementation of professional development. Adaption level I was where teachers made modification to the professional development they experienced based on their own context. Adaption level II was where teachers made adaption which they have not witnessed in the professional development to suit their students' needs.

A 7-year longitudinal study involving 48 projects in the National Science Foundation's Local Systemic Change (LSC) was conducted by Heck et al. (2008) to investigate the relationship between teacher participation in professional development and teachers' attitudes, preparedness, and classroom practices in mathematics. The instrument used for the study was questionnaire for both teachers and principals. Using different analytical approaches such as hierarchical linear modelling (HLM) approach and structural equation modelling (SEM) the researchers found that teacher participation in LSC professional development was positively related to teacher reported classroom practice. The researchers concluded by re-echoing the need to attend to factors that affect teachers' ability to change their teaching practice.

Johnson (2007) investigated how a two-year long professional development impacted on the instruction of six science teachers in the USA. Using observations and interview, it was concluded that the teachers were able to apply the standards-based instruction emphasised in the professional development but in different ways.

A study was conducted to examine the impact of a 2-week long professional development programme involving teams consisting of secondary school science teachers and two students each on monarchy butterfly ecology by Jeanpierre et al. (2005). In all 44 teachers and 86 students took part in the 2-week project. Using a mixed method approach the study found that the number of teachers giving opportunities for student enquiry increased significantly after the programme.

In a longitudinal study to determine the effects of professional development on teaching practices by Desimone et al. (2002), it was found

that professional development that focused on a specific teaching practice (technological, instructional or assessment) increased teachers' use of the practice in the classroom.

Impact of Professional Development on Students Learning

Professional development of teachers leads to improvement in teaching practice and increase student learning (Luft & Hewson, 2014; National Academy of Sciences, Engineering and Medicine, 2015). The process of professional development is policy directed and concern with student learning (Luft & Hewson, 2014).

In by case study conducted by Venville and Dawson (2010) in Australia, teachers participated in a professional development programme that focused on improving students' skills in the use argumentation, informal reasoning and conceptual understanding of science. After the programme, the teachers taught argumentation to their students during one class period. In the following two class periods, students used their newly acquired skills. The quantitative results from this study indicated that the students of the teachers who participated in the professional learning event significantly improved in their use of argumentation, informal reasoning and conceptual understanding.

Using cross sectional data from a California elementary school teachers' survey and California Learning Assessment System (CLAS) student mathematics scores, Cohen and Hill (2000) investigated the relationship between teachers' participation in student curriculum workshops and changes in teachers' practice and student achievement. By the use of regression analysis, they found that the teachers' engagement in student curriculum

workshops was positively correlated with both the use of reform-oriented practice in class and their students' mathematics scores.

Ingvarson et al. (2005) indicated that there is more confidence in measuring the impact of professional development on teaching practices than impact on students' outcomes. In this study the impact of professional development on student will not be considered partly because of reason cited by Ingvarson et al., and also due to the fact that the students cannot be easily followed because of time constraints since they are posted to different parts of the country to go and teach.

Contextual Factors Affecting Professional Development

Professional development takes place within a context (school, district, regional and national) which affect the content, process and effects (van Driel et al., 2012). Organisational factors have strong influence on the impact of professional development as they determine whether professional development will have impact or not. Organizational context is a key variable when it comes to professional development implementation since they can support or thwart the expected outcome of professional development (Luft & Hewson, 2014). The impact of professional development activities in bringing about change in the knowledge and practice of the teachers is influenced by the context, teachers' previous knowledge and skills, the type of knowledge to be acquired and the network to which the teacher belongs to (National Academy of Sciences, Engineering and Medicine, 2015).

According to Guskey (2002), a lot of factors account for the ineffectiveness of professional development key among them being the failure to take into consideration two crucial issues; the motivating factors for

teachers to engage in professional development and the process by which change in teachers occur. Other factors that affect the implementation of professional development include existing curriculum, standards, principals and colleagues, (Opfer & Pedder, 2011; Supovitz &Turner, 2000).

The Teacher-Centered Systemic Reform model (TCSR) attach importance to context of teaching characteristics of teacher, thinking of teacher, and relation among them as powerful factors affecting the implementation of reforms in the classroom practices (Gess-Newsome et al., 2003). Gess-Newsome et al. (2003) argued that structural and cultural context in which the teacher finds him/herself affect his/her teaching practice. Gess-Newsome et al. identified structural context to include the characteristics of the school setting such as arrangement of furniture, subject area, schedules, textbooks, test, teaching and learning materials and students. School contextual factors are important predictors of reforms in teaching. These school factors together with district and state policies are "powerful mediators' in influencing the impact of professional development (Supovitz & Turner, 2000).

Professional development is affected by teacher's personal context such as science knowledge and "frames of interpreting policies', school schedules, resources and time for planning and reflection; "vision and leadership' and "collective commitment" (Penuel et al., 2007). As Heck et al. (2008) put it that "teacher capacity interacts with system capacities [to affect professional development meant] for reform" (p.115). It is therefore important that both resources needed for implementation and likely barriers

are considered for professional development in science education (Penuel et al., 2007).

Heck et al. (2008) concluded their research by re-echoing the need to attend to factors that affect teachers' ability to change their teaching practice. Penuel et al. (2007) advocated for the need to attend to local barriers from school environment that teachers perceive to be barriers of professional development implementation. This is because "even the highest quality professional development programs are limited in the likelihood of changing classroom practice when there are major disincentives for teachers to implement what they are learning" (Heck et al., 2008, p.118). Several empirical studies have looked at how the various contextual element affect professional development implementation (Ebert-May et al., 2011, Klein & Riordan, 2009; Supovitz & Turner, 2000).

A study was conducted after two national professional development programmes which were aimed at increasing teachers' knowledge about the principles of active learning and scientific teaching (Ebert-May et al., 2011) The researchers used survey and video analysis of classroom teaching in the data collection process. A total of 221 participants were involved in the survey out of which 77 were selected for the video analysis. It was identified that the following were factors affecting teachers' implementation of professional development skills:

> (1) time constraints (time to plan, develop, or adapt materials; grade and give feedback; train colleagues or teaching assistants; and balance teaching with other activities), (2) students (attitudes toward teaching methods and course evaluation feedback), (3) implementation

(classroom infrastructure and use of technology), (4) support (through the campus administration, teaching rewards, tenure, financial, staff), and (5) cooperation (of departmental and other faculty, teaching assistants, and staff.

A qualitative case study approach was use by Klein and Riordan (2009) to study eight teachers from New York City who participated in a professional development on the use of expedition in teaching. The researchers used interview and observation in the data collection process. After the analysis of the data, Klein and Riordan found that even though participants agreed that the principles and practices espoused in the professional development were good they thought it was not fit for their context, therefore some of the teachers rejected its implementation. Some of the teachers cited that students' skills and thinking level and school policy which were not appropriate for the implementation as their reasons for the rejection. The researchers identified the following as factors influencing how teachers implement professional development.

Engagement: The level of engagement and enthusiasm teachers have about professional development had positive influence on how they implemented the professional development practice in the classroom. Klein and Riordan advised that the initial enthusiasm and energy that comes with professional development must be cleverly managed and sustained if teachers are to transfer it to their classrooms for students to benefit.

Content area belief and knowledge: The researchers found that teachers' belief about the subject matter had direct impact on how they implement the professional development practice.

Assessment: It was found that assessment practices and policies also affected the way teachers implement professional development practices. However, the results of this study cannot be generalized since it involved only eight teachers.

Penuel et al. (2007) conducted a study using 454 teachers who undertook a professional development aimed at preparing them to implement materials from an international earth science programme. The purpose of the study was to examine the effects of different characteristics of professional development on teachers' knowledge and their ability to implement the programme. Data for the study were drawn from teachers' survey, professional development providers' surveys and from programme database. Data were analysed using hierarchical linear modelling (HLM) framework. It was found that resources like equipment and technology had significant impact on the implementation, teacher knowledge and changes in science teachers' practices.

In a study conducted by Kannapel, Aagaard, Coe, and Reeves (2001) to determine impact of the Kentucky Education Reform Act, the researchers found that even though teachers were willing to practice the various elements of Standards-based instruction, many of them resorted to their traditional instructions. This was attributed to a lack of follow-up support after the professional development, as well as teacher fears about how students would fare on state tests.

Supovitz and Turner (2000) employed hierarchical linear modelling to study the relationship between professional development and reform teaching practice. Using survey data from 3464 teachers and 666 principals in National Science Foundation Teacher Enhancement program called the Local Systemic

Change (LSC) initiative, they identified the following as school factors that influence teachers use of reform practices; supportiveness of the school principal, resource availability and socio-economic conditions. Supovitz and Turner, found that teachers who believed they had support from their principals reported significantly greater use of reform practices than those who did not believe they had the needed support from their school authorities. Schools' available resources, such instructional materials, time for teachers to plan and prepare lessons, and availability of science relevant supplies, also had a statistically significant influence on teachers' practices. Socio-economic condition of the school that is poverty had great influence on teachers' practices as teachers from poorer schools seemed to use less of the reforms practices than their colleagues from schools whose students' population are well to do. The type of community in which the school is located also influenced teachers' reform practices

Professional Development and Teacher Background Characteristics

A relationship between professional development outcomes and teachers' background characteristics such teachers' experience and qualification must be taken into consideration when planning, implementing and evaluating professional development (Heck et al., 2008). Teacher characteristics include prior experience, content knowledge, beliefs, and attitudes (Desimone, 2009).

A study was conducted by Ebert-May et al. (2011) after two national professional development programmes: Faculty Institutes for Reforming Science Teaching (FIRST II) and the National Academies Summer Institute on Undergraduate Education in Biology (SI) at the University of Wisconsin

which were all aimed at increasing knowledge about the principles of active learning and scientific teaching. The researchers used survey and video analysis of classroom teaching. A total of 221 participants were involved in the survey out of which 77 were selected for the video analysis. From the analysis of the results of the survey, it found that the most significant and consistent predictor variable on reform teaching practice after professional development was teaching experience that is the number of years of teaching. There was a negative correlation between years of teaching and implementation of reform teaching practice showing the new teachers implemented the reform based teaching practice introduced in the professional development to a greater extent than the experienced teachers.

A qualitative case study approach was use by Klein and Riordan (2009) to study eight teachers from New York City who participated in a professional development on the use of expedition in teaching. The researchers identified teaching experience as a factor affecting professional development implementation. They noted that one big challenge in professional development is how to "differentiate" professional development for teachers with different teaching experience.

A study was conducted by Desimone, Smith, and Ueno (2006) using data from a survey, it was found that extent of teachers' content knowledge in mathematics had an impact on content-focused and sustained professional development participation. The researchers defined the extent of teachers' content knowledge to be the type of degree in mathematics and mathematics education. Using multinomial logit analysis, the researchers found that teachers who have their major in mathematics or mathematics education were

more likely to participate in sustained content-focused professional development than teachers who did not major in either mathematics or mathematics education.

A study was designed to examine the relationship between features of a high quality professional development and self-reported change in teachers' knowledge and skills and classroom teaching practices (Garet et al., 2001). The study data was part of national evaluation of Eisnehower Professional Development programme which provide financial support for the professional development of science and mathematics teachers. The researchers used data from Teacher Activity survey of 1027 teachers in 358 districts. After the analysis of data, it was found that teachers experience in teaching had significant positive relationship with changes in teacher practices after engaging in professional development. However, there was a negative correlation between teachers' experience and enhancement in their knowledge and skills.

Supovitz and Turner (2000) conducted a study to examine the relationship between professional development and reform indicators. The study found that teachers' years of experience had significant negative correlation with their investigative classroom culture while positively correlating with their use of inquiry based teaching practices.

Summary of Literature Review

The literature review has explored both theoretical and empirical perspectives of the problem understudy. It has emerged from the literature review that professional development has moved from the more traditional forms such as workshops which treat teachers as mere spectators (Ingvarson et

al, 2005) to a reform type which is job embedded, linked directly to the teachers' work in an individual or social form (Desimone, 2009).

It came to light from the review that many researchers have produced various list of essential characteristics of an effective professional development some of which are based on the analysis of literature on professional development (Desimone 2009; Ingvarson et al., 2005; Supovitz & Turner, 2000; Wilson & Berne, 1999). But now, a consensus has been reached on the key features of an effective professional development which include content focus, active learning, coherence, duration and collective participation (Desimone, 2009). These features have been empirically tested in many studies (Desimone et al., 2002; Garet et al., 2001; Ingvarson et al., 2005, Penuel et al. 2007).

It has been realized that professional development holds the keys to improving teaching and learning of science (Supovitz & Turner, 2000) and are designed as part of reforms efforts with the aim of implementing innovation in science education (van Driel et al., 2012). Most professional development programmes are designed to enhance teachers' knowledge and classroom practices. It has emerged that the impact of professional development on teachers' instructional practices and knowledge is affected by school contextual factors (such as leadership vision and support, policies and so on) and teachers' personal context such as their science knowledge (Penuel et al., 2007; Supovitz & Turner, 2002). However, most studies on professional development neglect the impact of school context on professional development (van Driel et al., 2012).

It also emerged that research on professional development for physics faculties at higher institutions were very rare as most studies on professional development have concentrated on teachers at the lower levels (Luft & Hewson, 2014). This study which thus looks at the impact of professional development on the teaching of physics at Colleges of Education in Ghana by considering how contextual factors affect the implementation of professional ideas will address the gaps in literature as far professional development is concerned.

Conceptual Framework

Figure 1 depicts the conceptual framework of the study based on the literature reviewed and the content of the professional development being undertaken by the tutors used in the study. The content of the professional development has three focuses or dimensions. The first focus or dimension deals with teaching practices which aim at changing tutors' instructional practices. The second and third dimensions of the professional development are about the NTS and NTECF and the 4-year B.Ed curriculum which are geared towards increasing tutors' knowledge about NTS, NTECF and the 4-year B.Ed curriculum. It is therefore conceptualized that the focuses or dimensions of the professional development (which form the independent variables) will affect teachers' instructional practices and increase their knowledge which will then influence the impact of the professional development as perceived by the tutors (which is the dependent variable). The overall impact of the professional development is assumed to be moderated by the context within which it is situated.

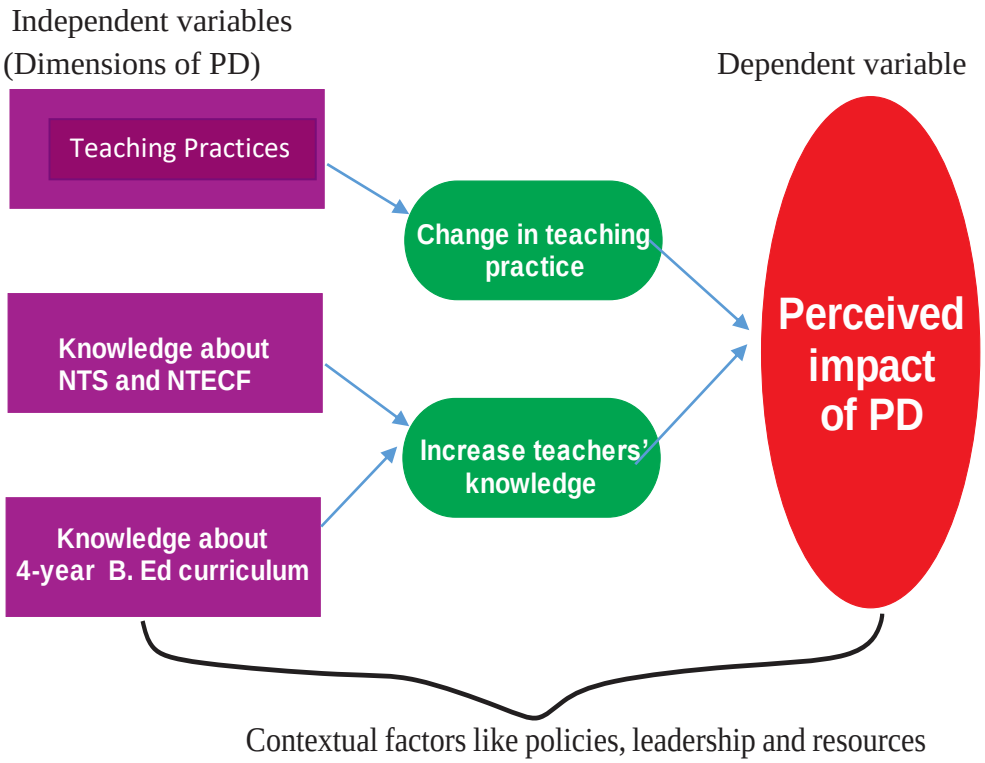

Figure 1: Conceptual model for the study

CHAPTER THREE

RESEARCH METHODS

The main purpose of this research was to assess the perceived impact of CDP on the teaching of physics at the Colleges of Education in Ghana. This chapter discusses the methods used in carrying out the study. It covers the research design, population, sample and sampling procedures, data collection instruments, data collection procedures and data analysis.

Research Design

The research design used for the study is mixed methods. Mixed method research design is a procedure that uses both quantitative and qualitative methods in a single study or series of study to understand a research problem (Creswell & Plano Clark, 2011). Mixed method approach provides a more thorough understanding of research problems than the use of only qualitative or quantitative approach alone (Fraenkel & Wallen, 2009; Creswell, 2012). Mixed method approaches are recommended to be used in studying teachers' professional development to help understand its complex nature (Desimone, 2009; Opfer & Pedder, 2011). Using mixed method to study science teachers' perception of the effectiveness of the standard for teaching and learning, Klieger and Yakobovitch (2011) noted that mixed design provide "a more reasonable picture". But Desimone (2009) believes that mixed method does not change the inherent biases associated with discussion of empirical measurement of teacher learning.

There are six types of mixed method designs which are convergent parallel design, explanatory sequential design, exploratory sequential design, embedded design, transformative design and multiphase design (Creswell,

2012). In this study, the convergent parallel design was employed so as to collect quantitative and qualitative data concurrently to have a better understanding of the impact of continuous professional development on physics teaching at colleges of education. It was chosen so that both the qualitative and quantitative data can complement each other to give a clear picture of impact of the professional development as perceived by the tutors. The quantitative and qualitative data were prioritized equally, analysed independently and mixed during interpretations as shown in Figure 2.

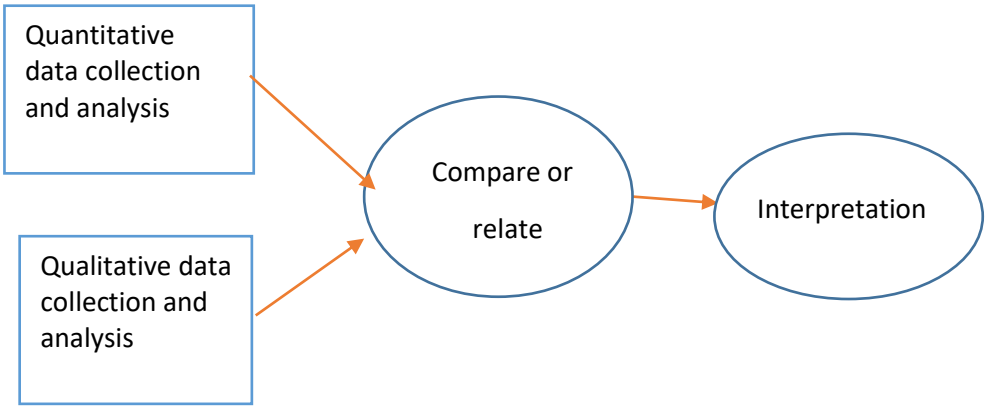

Figure 2: Framework for convergent parallel (Source, Creswell, 2012)

Justification for the Research Design

The main aim of the research was to assess the perceived impact of CPD programme on physics teaching at the colleges of education in Ghana. It was to find out the perception of the physics tutors about the impact of the professional development they are engaged in and to determine the extent to which physics tutors' participation in professional development influences their teaching practice.

It was also to identify how school context encourages or inhibits the physics tutors' use of the knowledge acquired in professional development. To achieve these objectives required gathering data from large population of

physics teachers and delving deep into data, therefore mixed method was deemed fit for the study. Survey was used in collecting data because it can give a good assessment of the critical feature of professional development, it is however limited in giving complex description or explanations about professional development (Desimone, 2009).

While arguing that no method of data collection should be regarded as biased and dismissed in professional development, Desimone (2009) noted that some methods are more suitable than others in gathering certain specific data on impact of professional development.

Population

Every College of Education physics tutor in the 48 public colleges of education in Ghana was considered to be a likely participant for the survey part of the study. Physics tutors from public Colleges of Education took part in the online survey because they have been involved in the professional development. The total population of physics tutors was estimated to be 96. Concerted effort was therefore, made by the researcher to reach as many college physics tutors as possible through an online survey.

Sample

In all 85 physics tutors from public Colleges of Education took part in the online survey. Out of this number who took part in the survey, 78 representing 91.8% were males with the remaining seven which represents 8.2% were females. A total of 52(61.2%) of the respondents were within the age of 30 to 49 years with only 6 (7.1%) within 50 years and above. The remaining 27(31.8%) tutors were within the age group of 40 to 49 years. Thirty-four representing 40% of the tutors have 11 to 20 years of teaching

experience at the college level with two which represent 2.4% having above 21 years of teaching experience. Of the remaining tutors, 17 (20%) have one to five years teaching experience while 32 (37.6%) have teaching experience ranging from six to ten years. Thirty-three which constitute 38.8% of the respondents have Master of Education (MEd) as their highest qualification while 25 (29.4%) have Master of Philosophy (MPhil). Nineteen which represents (22.4%) of the tutors also have Master of Science degree. Of the remaining, seven representing (8.2%) have first degree as their highest qualification with only one person having a PhD.

Sampling Procedure

The sample used for the study were physics tutors at the Colleges of Education in Ghana. The survey was made known to the physics tutors who took part in a workshop organized by the University of Cape Coast in May 2019. The link to the survey was shared on the WhatsApp platform of the physics tutors. The link was also shared on Colleges of Education Teachers' Association of Ghana (CETAG) WhatsApp and Telegram platforms where teachers were encouraged to share the link in their local platforms for physics tutors to see the link to the online survey so that they could complete it. All these avenues were used to ensure that as many physics tutors as possible could be reached.

The participants for the interview were purposively selected. Purposive sampling was used since the researcher was interested in tutors who had taken part in most of the professional development sessions and were therefore in a better position to give a right assessment of the impact of the professional development on their teaching. In all four tutors were selected for the

interview. These four tutors had teaching experience at the college level ranging from five to ten years with each having a master's degree. They were three males and one female.

Data Collection Instruments

The research instruments used in collecting data for the study were questionnaire and interview guide. The research was intended to find the perceived impact of the CPD the physics tutors in the colleges of education have been involved in. Questionnaire and interview were deemed as appropriate instruments because many people could be reached for their opinion on the issue at stake through the questionnaire while the interview was used to probe issues further as it enables the respondents to express their views in an unrestricted manner.

Questionnaire

The questionnaire was designed by the researcher as an online instrument using google form. The online questionnaire was used since it is convenient, cost effective, reliable and saves a lot time. Again, a lot of physics could be reached at the same time using the online questionnaire without the researcher travelling to the various colleges. Questionnaires are considered the most appropriate means of collecting data on large samples. But it has been criticised for mainly reporting "good' PD implementation whiles mostly ignoring "bad' implementation (Desimone, 2009).

A four point Likert scale which starts from not at all to a great extent was used for the items on the instrument to assess the perceived impact of the professional development on physics teaching at the colleges. The questionnaire was developed based on the content and aims of the professional

development that the tutors have been engaged in. The professional development had three dimensions: teaching practice dimension, NTS and NTECF dimension and the 4-year B.Ed curriculum dimension.

Items on the instrument were set to cover all these dimensions with each dimension constituting a subscale making the instrument multi-dimensional. There were 27 items on the teaching practice subscale, 7 on the NTS and NTECF and 8 items on the 4-year B.Ed curriculum. Apart from these items there were others that solicited for respondent's demographic information.

To ensure validity, the instrument was given to one professional development coordinator, two physics tutors and my supervisors to check whether the items were in line with the objectives of professional development. They were also to make sure that the items and words used in constructing them were clear and understandable. The suggestions made were taking into consideration in finalizing the online questionnaire which is attached as Appendix A.

Piloting of Instrument

The questionnaire was converted into an online survey form using google. It was then pilot tested using ten physics tutors. These teachers completed the online survey and their responses were used to establish the reliability of the instrument. The reliability of the whole instrument and the various sub-dimensions were determined using Cronbach's alpha reliability. The alpha value for the whole instrument was found to be .936. The teaching practice subscale had a coefficient of .901, NTS and NTECF had .942, and 4-year B. Ed curriculum was .951. These results are attached as Appendix B.

These reliability coefficients indicated that the instrument was very reliable (Gray, 2004) hence none of the items was deleted.

Interview Guide

A semi structured interview guide attached as Appendix C was prepared for the physics tutors to further explore the issues in the quantitative online survey. The instrument was prepared by the researcher under the guidance of my supervisors. The items on the guide were made to cover the main research questions which guided the study. These items were the baseline questions that all participants were asked. There were some occasions where follow up questions which were not part of the baseline questions were asked depending on interviewee responses. Interviews can provide effective explanations, illustrations and predictions for models about the working of systems but are prone to biases on the part of the interviewer. It is also burdensome to the researcher and the respondents and need complex analytical techniques (Desimone, 2009).

Data Collection Procedure

Collecting data for the study was done in two stages. The first stage involved the administration of online questionnaire to physics tutors. This online survey was done using google. The link to survey the was shared on various platforms for college tutors including physics tutors' WhatsApp platform where the physics tutors could access the link to complete the survey. The link was for one month, (between 27th April to 26th May 2019), for tutors to complete the survey. Consent form was attached to the survey in which tutors were to thick to indicate their willingness to participate in the study. In

all 85 physics tutors started and completed the survey giving a 100% completion rate. Google automatically collected the responses immediately it was completed and sent.

The second stage of the study involved conduction of interviews with some selected physics tutors after seeking their consent (see appendix D). The questions for the interview were sent to the tutors early before the interview day. This was done to ensure that tutors got ample time to reflect on their responses before the beginning of the interview. The interviews were conducted individually in a face-to-face manner within the colleges of the participants on dates and times agreed upon. The interview was audio recorded. The average time for the interviews was about 30 minutes. The whole data collection process took place within one month.

Data Processing and Analysis

Research questions one, two and three were answered using data from the online survey which were analysed using means and standard deviations. These analytical tools were chosen because they help in determining a representation of the overall impact of the various dimensions of the professional development as perceived by the physics teachers.

Research question four was answered using data from interview with tutors which was analysed topologically. The audio-recorded interview data were transcribed by the researcher. The data was analysed using 'typological analysis" (Hacht, 2002). Typological analysis begins by dividing the overall data set into categories based on predetermined typologies (Hacht, 2002). Initial typologies were generated by the researcher based on literature. The transcribed data were read by the researcher and information related to the

typologies were marked. Entries by typologies were read and recordings of the main ideas in the entries were done on a summary sheet. Data was read and coded according to patterns identified. Summaries were then produced for each participant. These summaries were then developed into themes.

The hypotheses were tested using data from the questionnaire which were analysed using analysis of variance (ANOVA). ANOVA was deemed as the suitable statistical tool to be used for the analysis because the experiences and qualifications of teachers were categorized at three or more levels (for example experiences of the teachers were categorized into 0-5 years, 6-10 years, 11 years and above while qualification was categorized into First Degree, M.Ed, M.Sc., M.Phil. and PhD) with the aim of determining if there are any statistically significant differences in the perceive impact of the professional development among the various categories.

CHAPTER FOUR

RESULTS AND DISCUSSION

The main purpose of this study was to assess the perceived impact of continuous professional development on the teaching of physics at the Colleges of Education in Ghana. Data for the research were collected using an interview and online survey. The online survey was analysed using descriptive statistics (i.e. mean and standard deviations) and inferential statistics specifically ANOVA. The interview was analysed thematically.

Sample Characteristics

Biographic data for respondents which include their gender, teaching experience, qualification and age are presented in this section.

Gender distribution of sample

A total of 85 physics tutors responded to the online survey of which 78(91.8%) were males and 7(8.2) were females. This indicates that majority of the physics tutors at the colleges of education are male.

Years of teaching in the college

The teaching experience of the respondents are given in Table 1. It can be observed from Table 1 that majority (34%) of the tutors had spent between 11-20 years teaching at the college while 17(20.0%) had taught between 1-5 years at the college. The results indicate that majority of the physics tutors have high experience in teaching physics at college level.

Table 1: Teaching Experience of Respondents

Number of years of teaching	Frequency	Percentage
1-5	17	20.0
6-10	32	37.6
11-20	34	40.0
21 and above	2	2.4
Total	85	100.0

Highest academic qualification of respondents

The highest academic qualifications of respondents are shown in Table 2 from which it is shown that the majority (38.8%) of the tutors have their highest qualification to be Masters in Education (MEd) while only one tutor had a terminal degree that is PhD.

Table 2: Qualifications of Respondents

Qualification	Frequency	Percentage
Ph.D.	1	1.2
M.Phil.	25	29.4
M.Sc.	19	22.4
M.Ed.	33	38.8
First degree	7	8.2
Total	85	100.0

Age of respondents

The ages of the respondents are presented in Table 3 which shows that 52 (61.2%) are between the ages of 30-39.

Table 3: Age of respondents

Age (years)	Frequency	Percentage
30-39	52	61.2
40-49	27	31.8
50 and above	6	7.1
Total	85	100.0

Research Question One

Research question one sought to investigate the perceived impact of the professional development on physics tutors' teaching practice. The responses to the items on the questionnaire were in a four point Likert format ranging from 0 (no impact) to 3 (great impact). For the purpose of the discussion, a standard mean of 1.5 which averages the scores was used for interpretation. Values below 1.5 were considered as low impact while values above 1.5 were considered as great impact. The responses of tutors to items that sought to determine the perceived impact of the professional development on instructional practices is presented in Table 4.

It can be seen from Table 4 that items on theme "Creative Approaches" which include items like, use of games, use of story-telling, use of songs, use of role play and use of modelling were all rated above the standard mean of 1.5 with the exception of the use of songs.

Table 4: Means and Standard Deviations Scores for Items on Perceived Impact of Professional Development on Teaching Practice

Item	Mean	Standard deviation
Use of games	1.65	.99
Use of story-telling	1.61	.98
Use of songs	1.40	1.13
Use of role play	1.72	.98
Use of Modelling	1.97	1.02
Use of questions to investigate misconception	2.19	.91
Avoiding common mistakes in questioning	1.84	1.06
Use of questions to support student learning	2.01	1.03
Use of close and open ended questions	1.79	1.07
Involving everybody in questioning	2.00	1.08
Use of questioning to promote thinking	2.01	1.18
How to initiate talk for learning	1.91	1.03
Building on what others say	2.08	.99
Managing talk for learning (e.g. using think pair share)	2.11	.88
Structuring talk for learning (e.g. using concept mapping)	1.79	.90
Use of low/no cost TLMs	1.89	.87
Use of books and other written materials	1.93	.92
Developing TLMs for use in teaching	2.02	.99
Use of outdoor and environment to enhance teaching	1.92	.92
Assessing students based on the National Teachers Standard	1.71	.87
Use of different assessment strategies such as self and peer assessment	1.98	.96
Use of open education resources	1.84	.96
Use of Group work	2.04	.99

Table four continue

Use of reflective practices	1.84	1.00
Use of action research	1.79	.96
Use of gender responsive pedagogy	1.94	.89
Use of games	1.65	.99
Practising inclusivity	1.96	.93
Average scores	1.89	.93

This means that all the activities under this theme had great impact on teaching practice except the use of songs which had small impact (M=1.40, SD=1.13). The use of modelling was rated the highest in this theme with a mean score of 1.97 and a standard deviation of 1.02, followed by the use of role play (M=1.72, SD= .98).

It can be seen from Table 4 that all items related to "Questioning" had rating higher than the standard mean of 1.5 indicating that the professional development activities that involve the use of Questioning had great impact. As it can be seen from Table 4, the professional development activity that has the greatest impact on instructional practice was the use of questions to investigate misconceptions (M=2.19, SD= .91). It is not surprising that in the interview a tutor specifically mentioned how the use of questioning as learnt in the professional development has helped him. The tutor stated:

> I also like the way they taught us to use questioning in our teaching because if I go to the classroom to teach and I only talk talk, the students will be bored…but if I use questioning for students to bring out their views I think it is good. I have gain more knowledge…on how well I should

> be able to think about the questions that I will be asking my students in the classroom. So it has helped me as a teacher.

It be seen from Table 4 that items like "how to initiate talk for learning," "building on what others say," "managing talk for learning (eg. use of think pair share)" etc which relates to the theme "Talk for learning" also had great impact on teaching practice. For example, the item "structuring talk deviation of .90.

It can be seen that group work also has great impact on teaching practice (M=02.04, SD=.99). This can be verified in the comments made by a tutor during the interview. The tutor stated as follows: "Engaging them (students) in group activities for them to discuss among themselves and give presentation on what they have discussed in their groups make the lesson interesting"

At the heart of the 4-year B. Ed curriculum and hence the professional development are the issues of gender and inclusivity. From Table 4, it can be seen that the items on these issues were rated by the tutors as having impacted greatly on their teaching. The item "Use of gender responsive pedagogy" had a mean score of 1.94 with a standard deviation of .89 while the "practising of inclusivity" had a mean of 1.96 and a standard deviation of .93. The great impact of these reform practices can be attested to in the comments made by tutors during the interview.

A tutor made a comment as follows;

> You go the elective physics class, you see few ladies who are there…so if you try to bring the female students on board using the techniques that T-TEL (professional

> development ideas) has taught us, more of the female students are now willing to answer questions during physics class or lesson than they used to do. Because you see them coil somewhere because they think that physics is for only males. But you try to use nice way to bring them on board…. they are doing well…Then we talk about inclusivity, it is not only for the females but, the male students also who are in the class (the general or core physics class) and they are shy are now drawn to come out because they know that anybody can be asked to do anything within the period.

As shown in Table 4, the overall mean score and standard deviation for the impact of the professional development on instructional practice was 1.89 and .93. This shows that the overall impact of the professional development on instructional practice is great. This is corroborated by the interview conducted where tutors describe the professional development as having great impact on their teaching. For example, a tutor had this to say when asked about the impact of the professional development on his teaching practice.

> We started (the professional development) with the ones (ideas) that we use in the classroom so for now yeah it is that one. As for knowledge, teachers are supposed to acquire knowledge continuously but the professional practice which deals with how to handle classroom situation, I will say for now it is making great impact"

Research Question Two

Research Question was intended to find out the perceived impact of the professional development on physics tutors' knowledge about the NTS and NTECF. There were seven items on the questionnaire that measured the impact of the professional development on tutors' knowledge of the NTS and NTECF. The scores of the respondents are given in Table 5.

From Table 5, it can be seen that all the seven items measuring the impact of the professional development on tutors' knowledge about the NTS and NTECF had mean scores greater the standard mean of 1.50. This is shown in the overall mean of 2.22 with a standard deviation of .73. It implies that the tutors perceived that professional development has helped them in gaining knowledge and understanding of the National Teacher's Standard and National Teacher Education Curriculum Framework. For example, the item "Understanding of the National Teacher Education Curriculum Framework" was given the highest score with a mean of 2.34 and a standard deviation of .81. This was followed by item "Implication of the National Teacher Education Curriculum Framework on work as tutor" which had a mean of 2.25 and a standard deviation of .86.

Table 5: Means and Standard Deviations Scores for Items on Perceived Impact of Professional Development on Tutors' Knowledge About the NTS and NTECF

Item	Mean	Standard deviation
Understanding of the use of the National Teachers' Standard (NTS)	2.11	.82
Understanding the philosophy and legal underpinnings of the NTS	2.11	.91
Identifying which standards will be addressed by my lesson	2.31	.86
Understanding of the National Teacher Education Curriculum Framework	2.34	.81
Implication of the National Teacher Education Curriculum Framework on my work as tutor	2.25	.86
Implication of the National Teacher Education Curriculum Framework for student teachers	2.18	.90
Understanding of the proposed structure of the curriculum framework.	2.14	.87
Average score	2.22	.73

Among all the seven items on this subscale, the item "Understanding the philosophy and legal underpinnings of the NTS" was among items with the least mean but has the highest spread in terms of responses (M=2.11, *SD*= .91).

Research Question Three

Research question three sought to investigate the perceived impact of the professional development on physics tutors' knowledge about the 4-year Bachelor of Education Curriculum**.** There were eight items on the questionnaire that measured the perceived impact of the professional development on tutors' knowledge about the 4-year Bachelor of Education Curriculum. The scores of the respondents are presented in Table 6.

From Table 6, it can be seen that item "Integration of subject knowledge and pedagogical knowledge" had the highest mean score of 2.29 with a standard deviation of .84. This was followed by the item "Understanding of the philosophy, structure and content of the new 4-year Bachelor of Education curriculum" (M=2.28, SD=.68). The item "Understanding of the benefits and challenges of assuring quality delivery in the new curriculum" has the least mean score of 2.08 and a standard deviation of .93. This lowest mean is greater than the standard mean of 1.5 which indicates that all the items were rated by tutors as having great impact on tutors' knowledge about the 4-year Bachelor of Education Curriculum as depicted in the overall mean score 2.19 and a standard deviation of .87 which is also greater the standard mean of 1.5.

Tutors, however, expressed diverse views about the impact of the dimension of the professional development during the interview. One tutor

stated that "for the third one (4-year B. Ed curriculum) we have just started implementing it. I have not seen the impact yet because it is only this semester that I am handling level 100s".

Table 6: Means and Standard Deviations Scores for Items on Perceived Impact of Professional Development on Tutors' Knowledge About the 4-Year B.Ed

Item	Mean	Standard deviation
Understanding of the philosophy, structure and content of the new 4-year Bachelor of Education curriculum	2.28	.68
Inclusivity and equity standards in the curriculum	2.16	.91
Understanding of principles guiding learning outcomes	2.25	.84
Integration of subject knowledge and pedagogical knowledge	2.29	.84
Producing course manuals for the courses I teach	2.25	.86
Understanding of the features of supported teaching in school (STS).	2.13	.95
Aligning performance indicators, teaching and assessment	2.13	.96
Understanding of the benefits and challenges of assuring quality delivery in the new curriculum	2.08	.93
Average scores	2.19	.87

Another tutor expressed contrary view to this by saying:

> That one (the 4-year B. Ed curriculum) has open my eyes as to how I have to prepare course manuals by incorporating learning indicators for the course that

> I will teach in the degree programme. Once you are able the master that one you realize that, the issues of NTS, equity and inclusivity are also captured there. So for me the aspect of the professional development that has really impacted on teachers is the B.Ed curriculum professional development in which teachers were taken through for them to gain knowledge and prepare to teach the B.Ed curriculum.

Research Question Four

Research question four sought to identify the factors that affect the implementation of the professional development ideas by physics tutors. From the analysis of the interview data, it was identified that the factors that affect the implementation of the professional ideas can be put into two themes; positive and negative factors. On positive factors, commitment of school leadership and support of professional development team were the subthemes identified. Tutors believe that they are able to implement the ideas in the professional development because of the support from the professional development team. The team which comprise local tutors who are called Professional Development Coordinators and external team provide tutors with the needed support in the form of feedback, recommendations and suggestions. For example, one physics tutor states

> Although we have professional development team here, we also have T-TEL officials who come to help us. Sometimes they go to the classrooms to see

> whether we are practising them (the professional development ideas) there. And they also send people to come and help us with the implementation of some of these things that were are learning.

Another tutor also commenting on the support for implementation stated that

> Last semester they (the professional development team) came to my class to observe what I was doing and made recommendations and inputs... They (T-TEL officials) have been coming a lot. They even come to my class very often than the local ones. As for the local ones, my HOD is always around, he sits in my classes. Even today I had two teachers sitting in my class looking at what was happening.

The following factors were identified to have negative influence on the implementation of the professional development ideas: unwillingness to change, teachers' perception, lack of resources, lack of time, long period of the program and assessment policies. A tutor had this to say.

> You see change is very difficult. There are people (tutors) who have learnt these things at the professional development but you go to their classroom and they are still doing the old things because they are unwilling to change. This also affect the kind of impact we want to see.

On lack of resources it was indicated by one tutor that "… we are learning how to integrate ICT tools like projectors into our teaching but if you go to the

classroom and these materials are not there, it does not allow us to be able to implement very well".

One tutor lamented how teachers' perception about the professional development is negatively affecting the implementation by saying that,

> you see some teachers also have the perception that these things we are learning are from other countries and they want to just dump it on us. Somebody has collected money somewhere and we are now being used as guinea pigs to experiment other people's ideas.

Another factor that came out which tutors believe is having a negative effect on the implementation of the professional development is the long period of the professional development programme. A tutor indicated that:

> it really having negative impact on us because it is a kind of deception. We were made aware that we were just going to do it (the professional development program) for two years then after the whole exercise we get a certificate and everything ends. But it keeps on coming and we don't know when it will end. New modules are being developed every day and teachers are asked to go for them.

Tutors identified lack of time as also affecting the implementation of the program.

A tutor said,

> this semester for example we have a lot activities running on campus, sporting activities are there. As we speak now, the students have lost about six hours today because they

> have to go to the field for sporting activities. So imagine six hours every day within the week gone and there are other programmes, like SRC week. So the lack of time is really affecting the implementation.

Policies like assessment were also identified to impact negatively on the implementation of the professional development.

One tutor asserted this point by saying,

> there is also this issue about policy like assessment. If we teach using T-TEL approaches but the end of the semester is set by a different body without taking these (the professional development ideas) into consideration, do you think it will not affect the implementation? It will. Honestly speaking if we are to strictly go by what we learn at the professional developments we can't finish the course outline. So sometimes we have to bend the policies a little in order to go on so that our students can pass the end of semester exams.

Hypothesis One

Hypothesis one was tested to see if there was a statistically significant difference in the perceived impact of the professional development by the physics tutors based on their qualification. The differences were tested using the one-way analysis of variance (ANOVA) test to compare the mean scores of respondents at an alpha level of .05. The data was tested for "Homogeneity of Variances" assumption by inspecting Levene's test which was not significant (p =.318) (See Appendix E). The non-significant value suggests

that variances within the factor across qualification are assumed equal and hence, homogeneity of variances assumption was not violated.

As shown in Table 7, the result showed a non-statistically significant difference in the perceived impact of the professional development based on tutors' qualification [F (4,79)= .832, $p = .509$]

Table 7: ANOVA Test for Perceived Impact of Professional Development Based on Tutors' Qualification

	Sum of squares	df	Mean Square	F	Sig.
Between groups	.873	4	.218	.832	.509
Within groups	20.726	79	.262		
Total	21.599	83			

Hypothesis Two

Hypothesis two was stated to determine if there was a statistically significant difference in the perceived impact of the professional development by the physics teachers based on their teaching experience. The differences were tested using the one-way analysis of variance test to compare the mean scores of respondents at an alpha level of .05. The data was tested for "Homogeneity of Variances" assumption by inspecting Levene's test which was not significant (p =.726) as shown in Appendix D. The non-significant value suggests that variances within the factor across experience are assumed equal and hence, homogeneity of variances assumption was not violated.

ANOVA was used to compare the perceived impact of the professional development by the physics tutors with regards to their teaching experience. The result showed a non-statistically significant difference in the perceived

impact of the professional development based on the tutors' experience [F (3, 80) = .616, $p = .607$].

Table 8: ANOVA Test for Perceived Impact of Professional Development Based on Tutors' Teaching Experience

	Sum of squares	Df	Mean Square	F	Sig.
Between groups	.488	3	.163	.616	.607
Within groups	21.111	80	.264		
Total	21.599	83			

This section of the research discusses the results of both the qualitative and quantitative data in line with the under-listed research questions which guided the study.

1 What is the perceived impact of the professional development on physics tutors' teaching practice?

2 What is the perceived impact of the professional development on physics tutors' knowledge about the National Teachers Standard and National Teacher Education Curriculum Framework?

3 What is the perceived impact of the professional development on physics tutors' knowledge about the 4-year Bachelor of education curriculum?

4 What factors affect the physics tutor's use of the ideas acquired in the professional development?

The following research hypotheses were also tested.

1. There is no statistically significant difference in the perceived impact of the professional development by the physics teachers based on their qualification.
2. There is no statistically significant difference in the perceived impact of the professional development by the physics teachers based on their experience.

Impact of Professional Development on Teaching Practice

Most professional development programmes are organised with the aim of enhancing teacher knowledge and improving classroom practice (Ingvarson et al., 2005). The results from both the qualitative and quantitative data indicates that the tutors perceived the professional development to have great impact on the teaching of physics at the colleges of education in Ghana. The main function of the college is to train teachers for the basic level of education. This level of education needs interactive and student-centered approaches in teaching. It is therefore expected that college tutors will adopt interactive and student-centred instructional strategies in teaching the pre-service teachers who will also teach using these students'-centred approaches as they have experienced in their training. The professional development was therefore designed for college tutors to use interactive teaching approaches in teaching and training the students who will learn from the tutors (T-TEL, 2017).

From the interview conducted, tutors believe their teachings are more interactive and student-centred as they engage and involve the student in lesson through group and individual presentation and meaningful discussion.

This had led some of the students to employ such approaches in their teaching practices. For example, a tutor said:

> my teaching is more interactive than compared to my previous teaching experience. At first, I will take a topic and go through every aspect without given them (students) the opportunity…. I will be doing everything myself but now I involve them in most of the activities that go in the classroom. Topics that I had to handle everything on my own, now they also come in to share their experience through group discussion and presentations and I also become a student learning from them, so we all learn from each other.

Another tutor also indicated the professional development is making impact by saying "… because my students are doing well in terms of how I am using the T-TEL approaches (professional development ideas). And some of them (students) are also using them (professional development ideas) in their teaching practice."

The results show that because of professional development, tutors are able to use gender responsive pedagogies and inclusivity strategies to involve students interactively in physics classrooms at the college level. This result supports a study by T-TEL (2017) which was carried out to examine the impact of T-TEL programmes in the colleges in which it was concluded that "a growing number of tutors have mastered the use of student-focused teaching methods and gender-responsive instructional strategies"(p.38). Comparable results were found in an experimental research of science teachers'

professional development programme, involving 125 teachers and 1676 students by Price and Chiu (2018) who found that there was an effect on the teachers in their classroom practices as teachers in the treatment engaged in more interactive instructional practice than those in the control group. The result obtained this current study is a contradiction of the view of Birdman et al., (2000) who indicate that professional development that generally focus on teaching techniques without focus on content are ineffective.

The result obtained from this current study is in support of the statement that the impact of professional development programmes to the science teacher leads to teacher ability to adopt teaching to the needs of different students and improvement in instructional practice (National Academy of Sciences, Engineering and Medicine, 2015). It is an evidence to support the fact that professional development can influence teachers' classroom practices (Guskey, 2000).

The impact of the professional development could be attributed to a lot of factors. First of all, the professional development is located within the tutors' working environment. Garet et al. (2001) argue that when professional development is located within the teachers' regular work day, teachers are more likely to connect the ideas in their classroom instruction. If teachers perceive professional development as increasing their competence and effectiveness, they will practice it (Guskey, 2002). Another factor that could account for the impact is the support in terms of input, recommendations and feedback provided by the professional development team both within and outside of the college. This is because according to Guskey (2000), providing follow-up and support in implementing new skills is a component of

professional development that is associated with increased application of new instructional practices.

Even though there is lack of consensus on the exact duration of professional development that is impactful, (National Academy of Sciences, Engineering and Medicine, 2015) however, support is given to professional development activities which extent over long period and include 20 hours or more of contact time (Desimone, 2011). Therefore, since the professional development has a long period of duration it could account for the impact.

Impact of Professional Development on Tutors' Knowledge About the NTS and NTECF

The results of the overall impact of the various dimensions of the professional development as compared with the standard mean is shown in Figure 3.

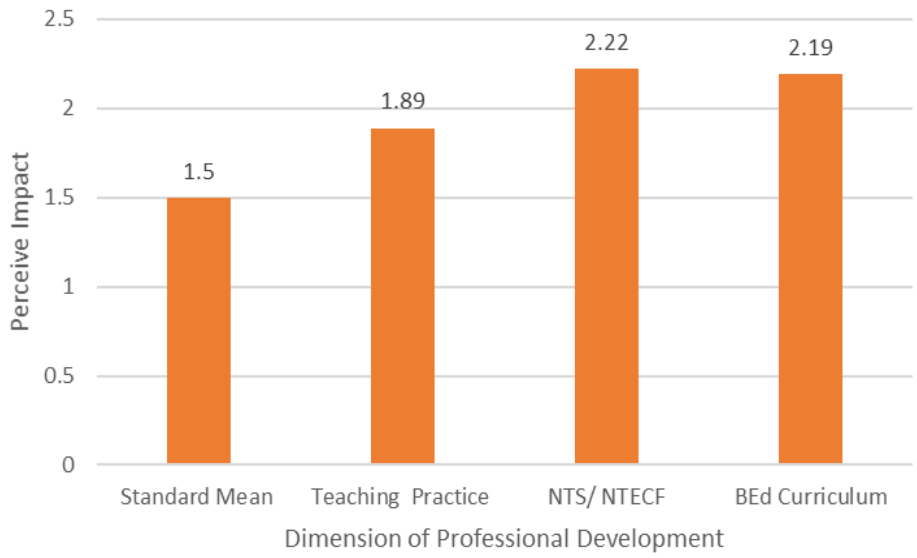

Figure 3: Overall means of the various dimensions of the professional development compared with the standard mean.

From Figure 3, it can be seen that all the dimensions of the professional had an overall mean value greater than the standard mean but

NTS and NTECF produced that highest overall mean of 2.22 which was followed closely by B.Ed curriculum also with an overall mean of 2.19. This implies that the professional developments that were aimed at enhancing tutors' knowledge produced greater impact than the one which was aimed at improving tutors' instructional practices. Several studies show a positive correlation between professional development and teachers' knowledge and skills (Banilower et al., 2007; Heck et al., 2008; Penuel et al., 2007). According to van Driel et al. (2012), professional development can have an effect on teacher's cognitions (i.e. their knowledge, beliefs and attitudes).

With the NTS and NTECF having an overall mean of 2.22 indicates the impact of dimension of professional development on tutors' knowledge was great. This means that the tutors understand the philosophy, the legal underpinning and the use of the National Teachers' Standard. The results also mean that the tutors understand the NTECF and its implications on their works as tutors. The result implies that because of the professional development programme, the tutors now have a good working knowledge about the National Teachers' Standard and the National Teacher Education Framework and their implications for the tutors' work.

Impact of Professional Development on Tutors' Knowledge About the 4-year B. Ed Curriculum

The overall impact of that dimension of professional development was found to be 2.19 with a standard deviation of .87 as shown in Table 6. These results from the quantitative data indicate that impact of the professional development on tutors' knowledge about the 4-year bachelor of education curriculum was great. Tutors indicated the professional development has

enhanced their understanding of the philosophy, structure and content of the new 4-year Bachelor of Education curriculum, principles guiding learning outcomes and features of supported teaching in school.

The results mean that the professional development has greatly impacted tutors' knowledge on issues of inclusivity and equity standards in the curriculum and integration of subject and pedagogical knowledge. However, the results from the qualitative data indicated tutors' assessment of the impact of this dimension of the professional development was varied. This could be due the way tutors assessed the impact. While some of the tutors might have looked at immediate impact in terms of the knowledge acquired others might have looked at the impact from the long term application of the knowledge. So those who assessed the immediate impact indicated that the programme had impacted on their knowledge but those who assessed the long term impact in terms of the application of the knowledge believed it is not making impact now which agrees with Guskey (2000) assertion that impact of professional development demands time for "adaptation, adjustment and refinement." Better results are obtained during the second year of implementation as there will be refinement and efficiency of effort while the first year will be for experimentation.

Factors Affecting the Implementation of Professional Development Ideas

From the interview data, it came out that the contextual factors affect the professional development implementation both positively and negatively. This is supported by van Driel et al. (2012) who state that context within which professional development takes places affects its content, process and impact. It was identified that commitment of the school leadership and

support of the professional development team were factors that affected the implementation positively. "Vision and leadership" and "collective commitment" have been noted by Penuel et al. (2007) to affect professional development.

Tutors reported during the interview that impact of the professional development on the teaching of physics was due to the commitment of the leadership of the school who have ensured that the professional development is part of the weekly activities of the colleges. Support was identified to be a major factor that positively affected the implementation of the professional development ideas. According to Guskey (2000), providing follow-up and support in implementing new skills there are parts of professional development that are associated with increased use of new instructional practices. Therefore, the support which were provided in a form of feedback, suggestions and recommendations by the professional development team and other teaching staff enabled the physics tutors to be able to practice the ideas taught in professional development. Providing opportunities for teachers to get support and mentorship during implementation of professional development ideas makes the programme effective (Ingvarson et al., 2005). Ebert-May, et al (20011) carried out a researcher in which it was identified that support of school administration and cooperation of staff were some of the factors that influenced teachers' implementation of the professional development ideas. Supovitz and Turner (2000) also identified supportiveness of the school principal as a factor that affected teachers' capacity to apply reform practices in their classroom. However, Kannapel et al. (2001) attributed teachers'

inability to practice ideas learnt in professional development programme to a lack of follow-up support after the programme.

The impact of the professional development was affected by tutors' personal context and institutional factors. The following tutors' personal context and institutional factors were identified to have negatively influenced the implementation of the professional development ideas: unwillingness to change, teachers' perception, lack of resource, lack of time, long period of the program.

It was found out that unwillingness of some of the tutors to change was a factor that negatively affect the implementation. But trying to change the teaching practices of teachers is a very difficult task to achieve because the process requires concerted efforts (Johnson, 2007). Southerland et al. (2016) claim that for change in teaching practice to occur, there must be a balance between teachers' "pedagogical discontentment" (i.e. the degree to which teachers are dissatisfied with their teaching practice and want to change) and their self-efficacy. This implies that some of the tutors are satisfied with their old teaching practices and do not have the belief that it can be changed. They are therefore holding on to their old teaching practice despite being introduced to reform practices.

One factor that has consistently been mentioned to have strong impact on the implementation of professional development ideas is resources. Some of reasons why professional development is considered ineffective are that some professional development present ideas that cannot be practicalized because of lack of resources (Guskey, 2000). It was found that lack of resources such as physics laboratory and technological tools like projectors

were some of the factors impacting negatively on the implementation process of the professional development. This result supports a research conducted by Penuel et al. (2007) who found that resources like tools and technology had significant impact on the implementation, teacher knowledge and changes in science teachers' practices after the teachers had undertook a professional development. Supovitz and Turner (2000) also found schools' available resources, such teaching aids, time to design and prepare lesson, and availability of science relevant supplies, also had a statistically significant influence on teachers' practices after engaging in professional development.

The lack of impact of professional development has been attributed to the shortness in intensity and length of these program mmes (Supovitz & Turner, 2000) as researchers (Desimone, 2009; Heck et al., 2008, Supovitz & Turner, 2000; reported that professional development which has long period has positive impact. However, the result from the interviews showed that the long period of the professional development is negatively affecting the implementation. This is supported by Kennedy (1998) who argues that the longer the period of professional development the more likely that other factors could influence the outcome. She further argues that long period of professional development could cause teachers to lose interest in the programme (and its implementation).

Difference in Perceived Impact of the Professional Development Based on Tutors' Qualifications

The result from the ANOVA as shown in Table 7 indicates a non-statistically significant difference in the perceived impact of the professional development based on tutors' qualification. This means irrespective of the

qualification of the physics tutors, they perceived the impact of the professional development to be the same. There were three major qualification levels of the physics tutors; PhD, Masters and First Degree as shown in Table 2. Given that all the dimensions of the professional development were impactful and that there was no difference in the perceived impact it can be deduced that PhD, Masters and First Degree holders who are teaching physics at colleges of education believe that professional development is making an impact in their teaching. This could be due the fact that these reform ideas (especially those which deal with knowledge) which are being taught at the professional development session are new, therefore tutors no matter their qualification find the information useful. For example, the idea about NTS and Supported Teaching in Schools in the 4-year B.Ed curriculum are all new reforms in the Ghanaian Educational Sector for which all categories of tutors will need to be abreast with.

The results however contradict a research carried out by Desimone et al. (2006) where, it was observed that extent of teachers' content knowledge (which is based on teachers' qualification) in mathematics had an impact on their participation professional development.

Difference in Perceived Impact of the Professional Development Based on Tutors' Experiences

The result from the ANOVA as shown in Table 8 indicates a non-statistically significant difference in the perceived impact of the professional development based on tutors' experience. This means irrespective of the experience of the physics tutors, they perceived the influence of the professional development to be the same. This could due to the fact the

changes in the educational sector brought about largely by technology coupled with government reforms, will require that all the tutors acquire some new knowledge and skills. Luft and Hewson (2014) posit that an on-going learning experience which comes about as a result of professional development begins and end with the teachers' career. It therefore means that teachers, no matter their level of experience need professional development. This is true for teachers who have experience but are encountering new concepts of teaching as well as for new teachers who are coming into the profession (National Academies of Sciences, Engineering, and Medicine, 2015). It is therefore not surprising that there was no difference in the perceived impact of the professional development based on the qualification of the tutors.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The main purpose of this research was to assess the perceived impact of continuous professional development programme on physics teaching at the colleges of education in Ghana. The study was guided by the under-listed research questions and hypotheses.

1. What is the perceived impact of the professional development on physics tutors' teaching practice?
2. What is the perceived impact of the professional development on physics tutors' knowledge about the National Teachers Standard and National Teacher Education Curriculum Framework?
3. What is the perceived impact of the professional development on physics tutors' knowledge about the 4-year Bachelor of Education Curriculum?
4. What factors affect the physics tutor's use of the ideas acquired in the professional development?
5. There is no statistically significant difference in the perceived impact of the professional development by the physics teachers based on their qualification.
6. There is no statistically significant difference in the perceived impact of the professional development by the physics teachers based on their teaching experience.

The study employed a mixed method study design using both survey and case study to find out the impact of professional development as perceived by the physics tutors in the Colleges of Education. An online survey was

conducted which was followed by interview with some of the physics tutors. The survey data were analysed using means and standard deviations and ANOVA. Data from the interview were analysed thematically.

The key findings of the study are as follows;

1. The professional development is perceived by the physics tutors to have great impact on their teaching practice
2. Tutors are able to use gender responsive pedagogies and inclusivity strategies to involve students interactively in physics classrooms at the college level because of the PD programme.
3. The perceived impact of the PD on physics tutors' knowledge about the NTS and NTECF and the 4-year B. Ed Curriculum is great.
4. It was found that the commitment of school leadership and support of the PD team help in the implementation of the professional development ideas
5. Unwillingness of tutors to change, tutors' perception, lack of resources, lack of time, the long period of the PD and assessment policies are factors thwarting the implementation process
6. There was no statistically significant difference in the perceived impact of the professional development by the physics tutors based on their qualification.
7. There was no statistically significant difference in the perceived impact of the professional development by the physics tutors based on their teaching experience.

Conclusions

From the findings, it can be concluded that the continuous professional development organised by T-TEL is having positive influence on physics teaching at the colleges of education. Tutors perceive their teaching to be more interactive. Tutors claimed that they are conscious of inclusivity, gender and equity issues in the physics classroom. Therefore, if the student teachers who are being trained by these tutors will learn these ideas from their tutors and practice them, teaching at the basic schools will be more interactive.

The professional development which focuses mainly on teaching practice was perceived by the tutors to be making impact and there is a little reason to doubt the tutors since they are willing to speak honestly about the impact of professional development programmes (Ingvarson et al., 2005). This result is contrary to the widely held view that professional developments that generally focus on teaching techniques without focus on content are ineffective (Birdman et al., 2000). The reason could be that physics contents taught at the college level may not be very difficult and so tutors are very comfortable teaching them but need the teaching techniques to making their teaching more student-centred since they are "trainers of trainee".

It can further be concluded that the continuous professional development has impacted on the physics tutors knowledge about NTS and NTECF. The impact of the professional development means tutors will be able to comprehend the usage of the NTS which is the foundation upon which the new curriculum was built (T-TEL, 2018). The results imply that the tutors will be able deliver the new curriculum in a way that ensures that the products are "teachers who have passion for teaching and leadership, are reflective

practitioners, and who engage with members of the wider community, always acting as prospective change agents" (T-TEL, 2018, p. 5).

It came out that the commitment of school leadership and support of the professional development team help in the implementation of the professional development ideas. Unwillingness of tutors to change, tutors' perception, lack of resources, lack of time and the long period of the professional development are factors thwarting the implementation process. This implies that the tutors are able to implement the ideas in the professional development given the needed support but faces challenges which need to be addressed.

Recommendations

From the findings of the study, the following recommendations are made:

1. There should be effort by the college authorities to provide basics resources like projectors for teaching in the colleges.
2. There should be an explanation by the T-TEL team to tutors as to why the programme has extended so long and if possible a time that the professional developments will end.
3. Assessment practices especially end of semester examination must be aligned with ideas tutors learn in the professional development programme.
4. T-TEL need to disabuse the minds of some of the tutors that the programme is being carried out because of someone's parochial interest and will not help the nation.

Suggestions for Further Research

It came to light that some of the student teachers are applying the ideas in their teaching practice so it is suggested a study could be conducted on how the professional development is impacting on preservice teachers in both on and off campus teaching practice.

This study used only teachers self-report to assess the impact of the professional development. It is therefore suggested that a study be carried out which combines both classroom observation and interview with the students to give a better picture of the impact of the professional development on physics teaching at the colleges of education.

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APPENDIXES

APPENDIX A

QUESTIONNAIRE FOR PHYSICS TEACHERS

INTRODUCTION

Dear tutor,

This questionnaire is designed to seek your views about the impact of the continuous professional development you are currently engaged in. It is part of an M.Phil. thesis work being undertaken at the University of Cape Coast. It is for academic purpose only, your assistance in providing an accurate information is kindly requested by completing the attached questionnaire. There is no wrong or right answer. Please be assured that the information that you provide in this survey will be treated confidentially.

SECTION A: BIOGRAPHIC DATA

1. Sex: Male [ ] Female [ ]
2. Years of teaching at the College

1-5 years [ ] 6- 10 years[ ] 11-20 years[ ] 21 years and above [ ]

3. Highest Educational qualification

PhD [ ] MPhil [ ] MSc [ ] MEd[ ] First degree [ ]

SECTION B: TEACHING PRACTICES

Indicate the extent to which your participation in professional development has impacted on your teaching in the use of the under-listed activities. Use the key provided

0 = not at all 1= to a small extent 2 = to a moderate extent 3= to a great extent

	0	**1**	**2**	**3**
Activities				
Use of Games				
Use of Story telling				
Use of Songs				
Use of Role play				
Use of Modelling				
Use of question to investigate misconception				
Avoiding common mistakes in questioning				
Use of questions to support student learning				
Use of close and open ended questions				
Involving everybody in questioning				
Use of questioning to promote thinking				
How to initiate talk for learning				
Building on what others say				
Managing talk for learning (e.g. using think pair share)				
Structuring talk for learning (e.g. using concept mapping)				
Use of low/no cost TLMs				

Use of books and other written materials				
Developing TLMs for use in teaching				
Use of outdoor and environment to enhance teaching				
Assessing students base on the National Teachers Standard				
Use of different assessment strategies such as self and peer assessment				
Use of open education resources				
Use of Group work				
Use of reflective practices				
Use of action research				
Use of gender responsive pedagogy				
Practising inclusivity				

Section C: National Teachers standard and Teacher Education Curriculum Framework

Indicate the extent to which your knowledge and skills were enhance in the under-listed areas as a result of your participation in the professional development. Use the key provided

0 = not at all 1= to a small extent 2= to a moderate extent 3 = to a great extent

Statement	**0**	**1**	**2**	**3**
Understanding of the use of the National Teachers' Standard(NTS)				
Understanding the philosophy and legal underpinnings of the NTS				
Identifying which standards will be address by my lesson				
Understanding of the National Teacher Education Curriculum Framework				
Implication of the National Teacher Education Curriculum Framework on work as tutor				
Implication of the National Teacher Education Curriculum Framework for student teachers				
Understanding of the proposed structure of the curriculum framework.				

SECTION D: 4-YEAR B. ED CURRICULUM

Indicate the extent to which your knowledge and skills were enhance in the under-listed areas as a result of your participation in the professional development. Use the key provided

0 = not at all 1= to a small extent 2= to a moderate extent 3 = to a great extent

Statement	**0**	**1**	**2**	**3**
Understanding of the philosophy, structure and content of the new 4-year Bachelor of Education curriculum				
Inclusivity and equity standards in the curriculum				
Understanding of principles guiding learning outcomes				
Integration of subject knowledge and pedagogical knowledge				
Producing course manuals for the courses I teach				
Understanding of the features of supported teaching in school (STS).				
Aligning performance indicators, teaching and assessment				
Understanding of the benefits and challenges of assuring quality delivery in the new curriculum				

APPENDIX B

RELIABILITY RESULTS

Reliability Statistics for the whole instrument

Cronbach's Alpha	No. of Items
.936	42

Reliability Statistics for teaching practice sub-dimension

Cronbach's Alpha	No. of Items
.901	27

Reliability Statistics for NTS and NTECF sub-dimension

Cronbach's Alpha	No. of Items
.942	7

Reliability Statistics for 4-year Bed curriculum sub-dimension

Cronbach's Alpha	No. of Items
.951	8

APPENDIX C

INTERVIEW GUIDE

1. Could you tell me little background about yourself with respect to your teaching qualifications and experience?
2. You have been involved in continuous professional development for the past four years, could share your experience with me regarding the implementation.
3. Can you identify some of the professional development ideas that you implement in teaching your students?
4. How has the professional development impacted your teaching practices?
5. How has the professional development prepared you to teach physics in the new 4-year B.Ed curriculum?
6. What do you think as some of the barriers that impede the effective implementation of the ideas espoused in the professional development?
7. How do these challenges impact on the implementation of the professional development ideas?
8. What kind of support do you need implementing the ideas taught in professional development session and how readily are they available?

APPENDIX D

CONSENT FORM

Consent form for physics tutors who will be interviewed on the research topic**:** *Perceived Impact of Continuous Professional Development Programme on Physics Teaching at the Colleges of Education in Ghana.*

I am a student at the Department of Science Education, University of Cape Coast, Ghana. I am conducting a study on impact of continuous development with the aim of finding out the perceived impact of continuous professional development programme on physics teaching at the colleges of education in Ghana

If you decide to be part of this study, I will interview you about your perception of the professional development, the impact it is making in your teaching and the factors affecting the implementation of the professional development ideas. The interview may take about 30- 45 minutes and will be tape recorded. You may request the recording to be stopped temporarily or permanently if at any time you feel uncomfortable.

I will conduct and transcribe the interview. You will be given with a copy of the interview transcript for review and approval. Your participation is voluntary and you have the right to withdraw from the project at any time. If you choose to withdraw, I will remove any of the information relating to you from the project, including any final publication, so long as it remains practicable to do. The research will not interfere with the normal teaching schedule.

All information gathered will be treated with strict confidence and your confidentiality and anonymity will be ensured in all publications. All data

gathered will be securely kept in a locker which only I will have access to and any data that can identify you will not be given to any other researcher or agency. The results of the study may be submitted for publication to national or international journals or presented at educational conferences. You may at any time ask for additional information or results from the study.

If you would like more information or seek further clarification about the research, you can contact me (on 0242533602 or e-mail: sonnycoffy@yahoo.com) or my supervisor Dr. Godwin Aboagye (on 0242187319 email: aduaboagye@ucc.ed.gh). The only anticipated risk associated with this project is the time you have to commit for the interview.

If you are interested in being part of the please **sign the consent form attached to this information sheet**. Thank you for your decision to be part of this research project.

Physics Tutors Consent Form for a study on the topic:

Perceived Impact of Continuous Professional Development Programme on Physics Teaching at the Colleges of Education in Ghana

I understand the aims and purposes of the research study being undertaken by ISAAC SONFUL COFFIE, an Mphil student from the University of Cape Coast.

I declare that:

- The study has been explained to me and I understand the information that was given to me on the information sheet.
- I am aware that my participation in this project is voluntary. I have had all questions answered to my satisfaction.
- I understand that my involvement will include an individual interview
- I understand that I can withdraw from the study at any time, which I do not have to give any reason for withdrawing. I understand what is required of me during this project.
- I understand that all information will be treated as confidential and that my anonymity and confidentiality will be maintained in all publications and that no information that could identify me will be given to other researchers or agencies. I understand that all data from this research will be securely stored by the researcher.
- I understand that within these restrictions, the findings may be submitted for publication to national or international journals or presented at educational conferences; that the results of the study can be made available to me at my request and that I can request additional information at any time.

- I know that interviews will be tape recorded and I can ask the recording to be stopped any time temporarily or permanently. I will be provided with a copy of interview transcript to check for accuracy.
- I have read the information sheet and consent form. I agree to participate in the study.

Name: _____

Signed: _____

Date: _____

APPENDIX E

LEVENE TEST

Test for Homogeneity of Variance for Tutors Qualification

Levene statistic	df1	df2	Sig.
1.191[a]	3	79	0.318

a. Groups with only one case are ignored in computing the test for homogeniety of variance

Test for Homogeneity of Variance for Tutors Teaching Experience

Levene statistic	df1	df2	Sig.
0.438	3	80	0.726