

**CHEMISTRY TEACHERS' PEDAGOGICAL CONTENT
KNOWLEDGE AND TEACHING EFFECTIVENESS AMONG
SECONDARY SCHOOLS IN BAYELSA AND DELTA STATES**

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**DEPARTMENT OF SCIENCE EDUCATION
DELTA STATE UNIVERSITY, ABRAKA**

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DEGREE OF DOCTOR OF PHILOSOPHY IN SCIENCE EDUCATION**

MAY, 2018

DECLARATION

I declare that this thesis is an original work carried out by me in the Department of Science Education, Delta State University, Abraka

ASIYAI, Anthony Asiyai

Date

CERTIFICATION

We the under-listed, approve that this thesis was carried out by ASIYAI, Anthony Asiyai, in the Department of Science Education, Delta State University, Abraka

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Prof O.P. Ajaja
Head of Department

Date

DEDICATION

This work is dedicated to my children Tuborlayefa, Oyinlayefa and Oyinemi.

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ABSTRACT

This study investigated the pedagogical content knowledge of chemistry teachers and their teaching effectiveness of public secondary schools in Bayelsa and Delta States. The study was guided by eight research questions and six hypotheses. A sample of 789 respondents comprising of principals = 80, students = 480 and chemistry teachers = 229 were selected using the simple random sampling techniques from public secondary schools having chemistry teachers in the two States. The instrument for data collection from respondents comprised of eight sections. Section A contained demographic information of the respondents. Section B and C contained classroom lesson observation guide used to assess the content and pedagogical knowledge of the teachers. The other sections of the instrument D, E, F G and H contained items for answering research questions 3-6 and their corresponding hypotheses. Descriptive statistics namely mean, standard deviation and Pearson coefficient of determination were used to answer the research questions. The hypotheses were tested using inferential statistics such as t-test and Pearson r. The findings obtained for lesson observations revealed that chemistry teachers in the two States demonstrate adequate content and pedagogical knowledge. However, chemistry teachers in Delta State appears to be more regular in writing daily lesson notes, exhibited good general knowledge of chemistry and have more adequate knowledge of entry behaviour for each topic. While Bayelsa State secondary school chemistry teachers appears to have more adequate knowledge of chemistry concepts and knowledge of instructional materials to be used for teaching specifics topics in chemistry. Nevertheless, Delta State secondary school chemistry teachers seems to show better pedagogical knowledge in areas such as making judicious use of questions to elicit students' understanding, the use of humour to make topics interesting and sustain students' attention. The hypotheses tested in this regard showed that there was a significant relationship between content knowledge of the teachers and their teaching effectiveness in Bayelsa and Delta States. There was a significant relationship between pedagogical knowledge of the teachers and their teaching effectiveness in Bayelsa and Delta States. In addition, the findings revealed that for Bayelsa State, there was a significant difference between the perception of male and female chemistry students regarding their teachers pedagogical content knowledge for teaching the subject, while for Delta State, there was no significant difference between the perception of male and female chemistry students regarding their teachers pedagogical content knowledge for teaching the subject. And that there was a significant relationship between pedagogical content knowledge of the teachers and their teaching effectiveness. Additionally, the findings revealed that there are several strategies that could be adopted for enhanced development of chemistry teachers' pedagogical content knowledge. The study concluded by recommending amongst others that Government of Bayelsa and Delta States should formulate policies for continuous updating of knowledge of teachers through in-built professional development programmes on a regular basis for chemistry teachers in the States

CHAPTER ONE

INTRODUCTION

Background to the Study

All over the world, teachers are recognized as powerful instruments in the education industry. Their primary obligation is to guide students rightly in the pursuit of knowledge, skills and positive values and help them to develop healthy attitude for living in harmony with other members of the society. Teachers of good quality can influence rapid societal transformation. This is because teachers are critical agents of reform and change. Teachers can influence change and help to enhance the transformation of the society if they possess the relevant knowledge, skills, values and competencies. Teachers are pillars the educational system and any effort to reform the system centre on them (Eze& Njoku, 2011; Ibe, Adah, & Ihejamaizu, 2013). As a result, teachers can facilitate reforms in the education system and the society if they possess adequate knowledge and instructional skills needed for teaching effectively for students' improved and meaningful learning.

Teachers are major factors in the education system whose input into building an effective school cannot be compromised. Education is a great tool for improving an individual's social, economic and political standing in the society. It is a strong factor for promoting an individual's economic well-being. With relevant education and training, an individual acquires the necessary skills, values and other attributes for living a self-sustaining life and improved economic growth. But when the education provided an individual is not relevant, he/she individual may not be able to live a useful life. Hence

much rely on the type of education and on the teacher who is the hub of the education process. Therefore, the quality of any pedagogical setting depends on the quality of its teachers in terms of their knowledge, skills and competences which could positively influence their academic and professional performances. This could be the reason why the FRN (2014) in the NPE asserted that “no education system can rise above the quality of its teachers”.

Science is derived from the Latin word “shire”, which means to know. Science is a way of seeking information (process) and an accumulated knowledge resulting from research (products) (Okeke, 2007). Science is a systematic investigation of nature with a view to understand and harness them to serve human needs (Okeke, 2007; Emendu, 2014). Science as a whole shapes the way one understands the universe, the planet, oneself and other living things (Ogunleye & Fasakin, 2011). Science has impacted seriously on the way people live largely through the application of scientific knowledge and technology.

Omosewo (2000) maintains that science education plays roles in the development of nations. As a result, every nation must take science education very seriously in all institutions of learning. In Nigeria, at the senior secondary stage science education is concerned with the teaching of physics, chemistry, biology and mathematics (Federal Ministry of Education, 2007). It focuses on the teaching of concepts in science, teaching methods and learners’ misconceptions (Kola, 2013).

Chemistry is one of the critical subjects in science education that deals with the study of the properties and compositions of substances and of the changes they undergo

(Okecha, 1993). He explained that every aspect of the world today-even politics and international relations is affected by chemistry. No wonder he wrote a book titled “Chemistry Rules the World”. He buttressed the important role played by chemistry, by asserting as follows: “No chemistry, no food; no chemistry, no shelter; no chemistry, no health care delivery; no chemistry, no comfortable life; no chemistry, no industrialization; no chemistry, no economic power” p.17. Chemistry is very important in scientific discoveries and inventions. There is hardly any endeavour in the sciences either pure or applied, where chemistry does not play some vital roles (Agogo & Otor, 2014). Fields of study like biochemistry, medical biochemistry and other basic medical courses require some chemistry for proper understanding of certain biological and related concepts. Medicine has broad interactions with chemistry. Furthermore, archeologists use organic remnants of the past to build up picture of human activities. In the fields of agriculture, medical sciences, pharmacy, engineering, dentistry and home economics, and even Faculty of Environmental Design, chemistry is required for entrance into the university to study the above courses.

Chemistry through its functionality and relevance, in content, practice and application, addresses the needs of virtually all students wishing to study science related course in any tertiary institution. Chemistry is central in the drive of global sustainable economic development (Emendu, 2014). Knowledge of chemistry is applied in industries such as fertilizer and insecticide, clothing as textile fabrics, cement, concrete, bricks and steel, medicine as in drugs and transportation such as fuel and alloy materials. Thus, the importance of chemistry to the development of nations cannot be over-emphasized. Chemistry teachers, like other science teachers, are trained through formal education, in

Colleges of Education and Faculties of Education in universities. During such training programmes, Chemistry teachers acquire subject matter knowledge. Chemistry teachers' knowledge is imperative in enhancing students' knowledge and academic achievement. Subject matter/content knowledge is the disciplinary knowledge obtained through formal training. Content knowledge is the teacher's understanding of the subject matter taught.

Pedagogical knowledge is the teachers' knowledge of the teaching and learning process in terms of how the content is organized by applying various techniques and how the class is managed (Berling, 2004; Dinama, 2013). Pedagogical knowledge enables teachers to bring in and use students' prior knowledge for successful understanding of the subject in educational process. Pedagogical knowledge enables a teacher to plan, implement and evaluate the education process while changing the subject matter into a form that will enhance students' learning (De Berg & Grieve, 1999). According to Koehler and Mishra (2009), pedagogical knowledge entails a "deep knowledge" about the process and practice or methods of teaching and learning. From all indications, pedagogical knowledge encompasses the sum total of educational purposes, values and aims of lesson. This involves lesson planning and development, implementation, students' learning ability and teacher's classroom management. Pedagogical knowledge is the inter section of the teacher's knowledge of the subject with knowledge of how to teach and how students learn (Niess, 2005; Dinama, 2013).

Pedagogical content knowledge is a combination of pedagogical and content knowledge. It embraces teacher knowledge of curriculum and curriculum materials, knowledge of classroom management and knowledge of students and their characteristics. Pedagogical content knowledge is the teachers' knowledge of content and

knowledge of teaching/pedagogy. Chemistry teachers need content knowledge, knowledge of pedagogy and pedagogical content knowledge in order to teach effectively to enhance students' academic performance in the subject at both internal and external examinations. The chemistry teacher must be equipped with all the necessary knowledge for them to be able to teach effectively and efficiently in order to be able to build a well rounded child who can favourably compete in adventures of life (Dinama, 2013). He emphasized that mastery of the content knowledge is vital to the chemistry teacher because, it enables him/her to confidently and satisfactorily deliver the various concepts, as well as plan, implement and assess its delivery to students. Therefore, the chemistry teachers' knowledge is a critical factor in enhancing students' meaningful learning, understanding of concepts in the subject, active involvement and interest in learning and their academic performance.

No single approach has been established for measuring a teacher's pedagogical content knowledge. Researchers across the universe have adopted several techniques including the use of questionnaire, classroom observation of teaching, asking students to write of their teacher's teaching. Observing teaching by teachers in the classroom has been expressed as providing great insight into a teacher's ability to demonstrate or perform pedagogical content knowledge (Shanaha and Tochelli, 2015)

Teachers are responsible for ensuring proper use of equipment and materials by learners to achieve expected objectives (Ikeobi, 2010). Therefore, the teacher is blamed when learners fail to exhibit the expected mastery in chemistry. It is based on the above reasons that the researcher deemed it fit to investigate chemistry teachers' PCK and teaching effectiveness in Bayelsa and Delta States, Nigeria.

Statement of the Problem

Teaching is a very complex activity, requiring several in-depth knowledge from the teacher. For students to learn meaningfully and productively, the teacher must be vast in content knowledge, knowledge of pedagogy and pedagogical content knowledge. The teacher's capability to teach effectively for students' productive learning and academic development is dependent on his/her pedagogical content knowledge. Researchers also uphold the fact that having knowledge of subject-matter is not enough to teach effectively. The teacher needs in-depth knowledge of pedagogy and pedagogical content knowledge for effective teaching. The quality of instruction is depended highly on the teacher's knowledge which has great influence on students' learning and academic progress. Even WAEC Chief Examiners Reports for several years highlighted the teachers' factors which has bearing with PCK an imperative factor responsible for students' poor performance in chemistry. Though studies have been conducted which examined teachers factors that affected students learning and academic performance, teachers' knowledge which could be a factor that influences their teaching effectiveness have not been well researched in Bayelsa and Delta States. The researcher is not quite sure what content and pedagogical knowledge chemistry teachers in the two states demonstrate in the classroom during lesson and how this knowledge influences their teaching effectiveness. The problem statement of this study therefore is: what content knowledge, pedagogical knowledge and pedagogical content knowledge do teachers possess for effective teaching of chemistry among public secondary schools in Bayelsa and Delta States?

Research Questions

The study was guided by eight questions as follows:

1. What content knowledge do secondary school chemistry teachers in Bayelsa and Delta States demonstrate during lesson in the classroom?
2. What pedagogical knowledge do secondary schools chemistry teachers in Bayelsa and Delta States demonstrate during lesson in the classroom?
3. What is the relationship between content knowledge and teaching effectiveness of chemistry teachers in Bayelsa and Delta States secondary schools?
4. What is the relationship between pedagogical knowledge and teaching effectiveness of chemistry teachers in Bayelsa and Delta States secondary schools?
5. What is the extent of teaching effectiveness of chemistry teachers in Bayelsa and Delta states public secondary schools?
6. What PCK do male and female chemistry teachers of public secondary schools in Bayelsa and Delta States possess for effective teaching of chemistry?
7. What strategies could be adopted for enhanced development of pedagogical content knowledge for teaching of chemistry?
8. What is the relationship between pedagogical content knowledge and teaching effectiveness among secondary school chemistry teachers in Bayelsa and Delta State?

Hypotheses

The first and second research questions were not hypothesized. Therefore, six hypotheses were formulated to be tested at 0.05 level of significance as follows:

1. There is no significant relationship between content knowledge and teaching effectiveness of chemistry teachers among public secondary schools in Bayelsa and Delta States.
2. There is no significant relationship between pedagogical knowledge and teaching effectiveness of chemistry teachers among public secondary schools in Bayelsa and Delta States.
3. There is no significant difference between the teaching effectiveness of chemistry teachers in Bayelsa and Delta state public secondary schools.
4. There is no significant difference between the mean scores of male and female chemistry teachers in Bayelsa and Delta States with respect to their pedagogical content knowledge for teaching chemistry.
5. The strategies for enhanced development of pedagogical content knowledge of chemistry teachers will not significantly differ in Bayelsa and Delta State public secondary schools.
6. There is no significant relationship between pedagogical content knowledge and teaching effectiveness of chemistry teachers among public secondary schools in Bayelsa and Delta States.

Purpose of the Study

This study investigated the pedagogical content knowledge of chemistry teachers and their teaching effectiveness among public secondary schools in Bayelsa and Delta States of Nigeria. Specifically, the study intends to:

1. Investigate the content knowledge chemistry teachers demonstrate during lesson in the classroom in Bayelsa and Delta States secondary schools;

2. Investigate the pedagogical knowledge chemistry teachers demonstrate during lesson in the classroom in Bayelsa and Delta States;
3. Find out whether there is any relationship between content knowledge and teaching effectiveness of chemistry teachers in Bayelsa and Delta States;
4. Ascertain if there is any relationship between pedagogical knowledge and teaching effectiveness of chemistry teachers in Bayelsa and Delta States;
5. Find out the level of teaching effectiveness of chemistry teachers in Bayelsa and Delta States public secondary schools;
6. Find out the level of pedagogical content knowledge of chemistry teachers in Bayelsa and Delta States public secondary schools.
7. Find out the strategies that could be adopted for enhanced development of pedagogical content knowledge for teaching, and
8. Affirm if any relationship exists between teachers' pedagogical content knowledge and teaching effectiveness of chemistry teachers in Bayelsa and Delta States.

Significance of the Study

The study may be of great significance to science teachers especially chemistry teachers, undergraduates in science education of federal, state and private universities, science education researchers, school counselling units, curriculum planners, principals and policy makers in science education.

It is hoped that the study results may provide knowledge base and process employed by chemistry teachers in developing pedagogical content knowledge in chemistry teaching for improving learners' performance. It may help beginning chemistry

teachers who could read through the thesis to have a clearer understanding of pedagogical content knowledge and ways of improving its' development, and know the relevance of pedagogical content knowledge and its development process so thus begin to develop their pedagogical content knowledge. In addition, chemistry teachers may be able to give a deep thought on own teaching practice and strengthen their pedagogical content knowledge. The findings may also expose chemistry teachers and science education researchers to what content knowledge and pedagogical knowledge entails. This exposition could help the teachers to begin to seek ways of self-improvement in their pedagogies and content knowledge for better instructional practices.

The study findings may be of benefit to education planners who are charged with planning education. They may use it as a useful guide in planning science education for teachers' instructional practices for better academic performance of students in chemistry. Additionally, education reformers who carry out reform in science education may find the findings of benefit in implementing some or all the suggestions proffered for better teaching and learning in the chemistry. Curriculum developers in science education could also benefit from this study. This is because the study would make policy recommendations on the strategies that could help in improving chemistry teachers' development of pedagogical content knowledge and its' relationship with their teaching effectiveness. The understanding of the strategies and their implementation by curriculum developers in science education could help in improving chemistry curriculum for better secondary level chemistry education. The result of this study could be used to improve chemistry education and or change policy about secondary school chemistry in Bayelsa and Delta States of Nigeria

School principals may also benefit from this study as it may help them to get a better understanding of pedagogical content knowledge, content knowledge and knowledge of pedagogy and strategies for improving it so that they would be able to budget adequately for their teachers' professional development programmes. Furthermore, the counselling units of secondary schools may adopt some or all of the suggestions given based on the findings of this study as a counselling guide when providing counselling services to students particularly those who are interested in chemistry, and thus provide useful counselling in pedagogies.

This study may also be of immense significance to researchers in science education as it will provide relevant related literature for review in similar studies. The findings may also guide science educators who plan and make policy when planning educational reforms in science education, especially chemistry.

Scope and Delimitation of the Study

The study examined chemistry teachers' pedagogical content knowledge for teaching and teaching effectiveness among Public Secondary Schools in Bayelsa and Delta States of Nigeria. The study covered only Public Secondary Schools in the six Senatorial Districts of Bayelsa and Delta States of Nigeria. Data for the study was collected from only chemistry teachers, principals and students in selected secondary schools.

Operational Definition of Terms

The terms used in this study are hereby defined to reflect their meanings as used in this study.

Content Knowledge: This refers to chemistry teachers' knowledge of the subject and the topic to be taught at any particular time or lesson. In this study, content knowledge is same as subject matter knowledge.

Pedagogical Knowledge: This is also referred to as knowledge of pedagogy. It means chemistry teachers' knowledge of instruction, knowledge of process and practice of teaching and teaching methods or approaches as well as classroom management.

Pedagogical Content Knowledge: this means knowledge of content and pedagogy, subject matter knowledge, knowledge of instructional strategies, classroom management and knowledge of students' preconceptions and misconceptions, and knowledge of ways of presenting some specific topics to enhance learners understanding.

Subject Heads: This refers to senior chemistry teachers who act as supervisors or mentors to other chemistry teachers in each school.

Teaching effectiveness: This means how good and efficient chemistry teachers are in their instructional practices in terms of knowledge, lesson planning, presentation, and assessment of students' learning, provision of feedback and evaluation of the lesson.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

This chapter reviews literature related under the following sub Headings:

- Theoretical Framework of the Study
- Conceptualization of Pedagogical Content Knowledge
- Concept of Effective Teaching in Relation to Pedagogical Content Knowledge
- Concept of Content Knowledge and Relation with Teaching Effectiveness
- Concept of Pedagogical Knowledge and Relation with Teaching Effectiveness
- Concept of Pedagogical Content Knowledge and Relation with Teaching Effectiveness
- Components of Pedagogical Content Knowledge
- Importance of Pedagogical Content Knowledge
- Pedagogical Content Knowledge and Quality Education
- Components of Pedagogical Content Knowledge for Teaching Chemistry
- Pedagogical Content Knowledge and Knowledge of Instructional Strategies for teaching Chemistry
- Assessing Teachers' Pedagogical Content Knowledge in Chemistry
- Strategies for Improving Chemistry Teachers' Development of Pedagogical Content Knowledge
- Appraisal of Reviewed Literature

Theoretical Framework of the Study

The study is founded or hinged on the theory of conceptual fields propounded by Vergnard in 1990. The theory contends that activity in situations is essential and that in

order to develop competences, operative and predictive forms of knowledge are essential. According to Olfos & Tatiana (2014), this theory is a developmental one having two aims namely: (1) to describe and analyze the progressive complexity regarding competences in chemistry developed by students during the course of learning the subject and (2) to establish better connections between the knowledge forms

Conceptual Fields theory see comprehending the learning as a process levered by actions accomplished in teaching, the theory provides frame and some principles for the study of development and learning of students' complex skills. The main emphasis of the theory is better understanding and comprehension of the process that promotes conceptual development and learning of students. The theory borrowed Piaget's and Vygotsky's legacies, examined from the angle of my own experience, have permitted me to discover a coherent explanation about how conceptual development and learning takes place or occur. From Piaget's perspective, the conceptual field theory was interested and keen in cognitive development of students, whereas from Vygotsky's perspective, the theory was more interested in learning, especially learning at school. Development is a consequence of learning and can take place independently of formal learning. The individual student can work intensively alone, after receiving enough direction and guidance from the teacher, reorganizing his/her former knowledge in the light of the new knowledge, and the new knowledge in the angle of his previous knowledge. Sound subject matter knowledge of the teacher is imperative for proper guidance and direction of students in their learning and cognitive development. This is quite similar to assimilation which Piaget considered fundamental to cognitive development. In terms of content knowledge, this theory contended that conceptual knowledge is the knowledge of

specific and general chemistry knowledge. Representational knowledge is the knowledge that relates with different forms of representations in chemistry. It encompasses all the specific or particular representations utilized by the teacher to assist students generate their building of knowledge and establishing relationships. This includes the teacher's use of drawings, examples, analogies, symbols, illustrations, pictures, charts, models, etc to facilitate students' meaningful learning and academic progress. In terms of pedagogical knowledge, the conceptual field theory lays emphasis on the teacher's knowledge of lesson planning, knowledge of teaching methods, knowledge of how to inter change teaching methods to elicit students' attention, interest and understanding during lesson, knowledge of students' prior knowledge that will help them face a task successfully in their new learning, knowledge of classroom management and control and knowledge of student characteristics that can help foster their learning and knowledge of how to evaluate students' learning.

In terms of pedagogical content knowledge, the conceptual fields theory emphasized knowledge of teaching of content which includes the teacher's knowledge about how to organize the curriculum and it's sequencing as well as his/her knowledge of constructivist conceptions and behaviourist learning theories. The actions involved are: task organization.

Conceptualization of Pedagogical Content Knowledge

The term pedagogical content/subject knowledge was first conceptualized by Shulman in 1986. According to Shulman (1986), the necessary content knowledge teachers are supposed to have for effective teaching fall into three categories such as content knowledge, pedagogical content knowledge and curriculum learning/knowledge. Shulman (1987), conceptualized pedagogical content knowledge as including seven professional knowledge base for teachers such as knowledge of general pedagogy like classroom management and classroom organization, knowledge of curriculum including curricular materials and programmes, knowledge of learners and their features such as learners preconceptions and misconceptions, knowledge of educational contexts, knowledge of instructional and educational ends, values, purposes, and their historical and philosophical grounds, pedagogical contents knowledge.

Grossman (1990) conceptualized pedagogical content knowledge as teachers' knowledge of representations and instructional strategies, knowledge of purposes of teaching, knowledge of students' learning and conceptions, and knowledge of curriculum and media. Pedagogical content knowledge has been seen to include knowledge of subject matter and knowledge of general pedagogy (Marks, 1990; Cochran et al, 1993, Fernandez-Balboa, 1997). Jan, Van Driel, Verloop and Vos (1998) explained the concept pedagogical content knowledge as teachers' interpretation and transformation of contents knowledge with regards to encouraging student learning. They emphasized that pedagogical content knowledge encompasses teachers' understanding of common and basic learning problems/difficulties and presumption of students.

Gess-Newsome and Carlson (2013) and Helms and Strokes (2013) in a pedagogical content knowledge summit, identified five main domains of teacher

professional knowledge as pedagogical knowledge, content knowledge, curricular knowledge, assessment knowledge and knowledge of students. They noted that these five knowledge influences and are influenced by the professional knowledge of a particular topic. Accordingly, the professional knowledge embraces knowledge of instructional strategies and representations of content, students' understanding and habits of the mind. The teacher is a insightful means, reflecting on their exercise/practice and reassesses it to accomplish improved outcome (Gess-Newsome and Carlson, 2013; Helms and Strokes, 2013).

Several studies have analyzed the significance of teachers' pedagogical content knowledge in promoting quality teaching. For example, Shulman (1992) emphasized that pedagogical content knowledge makes a difference for instructional quality and students' learning. Study conducted by Baumert, Kunter, Blum, Brunner, Voss, Jordan, Klusmann, Krauss, Neubrand and Tsai (2010) showed that an imperative positive relationship existed between a teacher's content knowledge and pedagogical content knowledge on instructional quality. Evens, Elen and Depaepe (2015) remarked that to improve the quality of education, it is important to invest on prospective teachers' pedagogical content knowledge. An understanding of pedagogical content knowledge will help to influence teachers' practice which is required to foster improvement in science teaching and science teacher education (Magnusson, Krajcik & Borko, 1999). The significance of pedagogical (educational) content knowledge in improving the quality of instruction and students' learning and outcomes cannot be over emphasized. Teachers need special knowledge to teach effectively professionally. According to Mitchell and Mueller (2006) cited in Ijeh (2012), pedagogical content knowledge is the overall knowledge the

educator has of the subject matter content that learners should master in a particular topic or subject and how it should be taught, so that effective and efficient learning can take place. From this perspective, it is clear that pedagogical content knowledge can be developed through constant practice of teaching in the classroom. Various studies, including Dooren, Verschattel and Oghenna (2005), Boerst (2003), Halim and Meerah (2002) and Van-Driel, Verloop and De Vos (1998), revealed that inadequate pedagogical content knowledge is one of the areas that require more attention in teacher education as many teachers are unable to enhance learners' performance due to dearth of content knowledge and pedagogical content knowledge. The teacher factors which bothered on pedagogical content knowledge such as poor knowledge of subject matter, poor instructional skills and poor teaching methods were the most critical factors attributable to learners' poor performance that have been identified by WAEC Chief Examiners Reports of 2010, 2011, 2012, 2014 & 2015. Other factors which appears to have bearing on pedagogical content knowledge which affects teaching have been identified by several researchers as inadequate textual materials, lack of teaching skills and competence by science teachers and teacher's poor knowledge of instructional material for teaching specific science topics (Brimoh & Okedegi, 2001).

Concept of Effective Teaching in Relation to Pedagogical Content Knowledge

The term effective teaching has been described by several researchers. Smith (1995) identified five factors that provide foundation for effective teaching as teachers' knowledge, interest and responsibility regarding learning, classroom and evaluation activities and exercises that encourage and promote learning, effective interaction between teacher and students as well as effective and successful feedback that setup or

forms the learning process in the classroom. According to Day (1999: 38), “teaching is more than a craft”. He argues that “teaching is an educational science and a pedagogical art”. Day (1999) suggests that teaching for reflective professionalism, should involve learning, participation, collaboration, cooperation and activism.

A lot of empirical studies have explored the characteristic of effective teachers as indicating that they possess common characteristics such as: having a broad understanding and comprehension of curriculum, aims/goals and objectives; broad range of instructional strategies; students high expectations; knowing and being familiar students; make available effective and useful feedback; be aware of student success; having sound knowledge of the subject content or topics and understanding what it takes to make headway or progress (Gipps, 1999; Wragg, Hayes & Chamberlain, 1998).

Vasutova (2001, Jones & Moreland, 2003a) maintains that teachers should have competence in subject knowledge/professional knowledge, curriculum knowledge, general pedagogy, communication or verbal skills likewise to social and psychological skills for student's meaningful learning.

Studies have shown that students improve in their performance when teachers allocate more of their time and energy concentrating on content, with learning exercises concentrated on the students' levels of comprehension and that they learn more successfully when the teacher arrange and organize new information in connection to earlier knowledge or information of the student (Brophy & Good, 1986; Jones and Moreland, 2003b). It has been demonstrated that where instructors' or teacher's subject knowledge is feeble or weak, certainty levels to teacher and to implement the curriculum of that subject are low, resulting to limited classroom practices (Harlen, 1999). All the

studies above, all laid emphasis on teachers' content knowledge, knowledge of pedagogy as well as pedagogical content knowledge.

Students learn and perform well when they are provided effective and sufficient opportunities to learn in a democratic classroom. A study carried out by Rivkiv, Hanushek and Kain (2005) using a sample of 4,000 students selected from 3,000 secondary schools in Kenya, their finding revealed that although school quality is a vital factor in student academic achievement, the teacher quality is the most significant factor or contributing factor to student academic success or achievement.

Jones and Moreland (2003a) found that good teacher content knowledge affects decision-making in terms of pedagogical strategies which can result in better learning opportunities. The study further revealed that sound content knowledge has a positive on planning, assessment, implementation of curriculum and curriculum development.

Harlen & James (1997) remarked that teachers can't give learning experiences, activities and exercises that guide learners improvement and progress toward understanding and comprehension of ideas if they themselves don't recognize what the ideas are. Gess-Newsome (1999) noted that, teachers with well-developed and improved pedagogical abilities and skills nevertheless experience problem in responding correctly to student concepts when they move beyond their area or sphere of content expertise. He maintained that with familiar content, teachers are able to focus more on levels of student understanding than "mechanical success or failure" (p. 62). This suggests that for best practice in teaching, teachers must continue to practice their teaching in their area of content expertise to enhance their effectiveness in teaching. According to Fleer (1999: 275), "the way the learning setting is organized is probably going to be as an immediate

consequence of the teachers' instructional content knowledge and philosophy on how children think and learn”.

Wilson and Penelope (2006) emphasized that during teaching and learning, teachers should use new teaching strategies/instructional approaches to enhance students' understanding of topics. The teacher's ability to use innovative teaching strategies/approaches is dependent upon his/her initial training, knowledge of pedagogy, content/subject matter knowledge, and curriculum knowledge, instructional skills and classroom management. They accentuated that learning is a process or course of action of active construction and an individual experience. As succinctly put by Alton-Lee (2003) and Gurney, (2007), quality teaching programme or curriculum goals are well aligned, pedagogy scaffolds response on student's engagement, pedagogy or teaching method promotes and advances learning orientations, students' self -regulation and thoughtful students discourse.

Good knowledge of the topic empowers teachers to develop learning chains of command, which give a blueprint or outline for devising evaluation or procedures (Carr, McGee, Jones, McKinley, Bell, Barr & Simpson, 2000). According to Ozden, (2008), content knowledge positively influenced pedagogical knowledge. Bell & Cowies (1997) research on assessment in Science education discovered that classroom interaction and dealing are reliant upon teacher's professional experiences and knowledge, Black & Wiliam (1998) on their part demonstrated a close connection between teachers formative or developmental interactions, the components or elements of a teacher personal instructional method, and their formation of their role. Teacher's professional knowledge is integral to the procedure of assessment, as knowledge or facts of the subject, how

students' learn and the interaction of these two elements supports or bolsters learning (Carr, McGee, Jones, McKinley, Bell, Barr & Simpson, 2000; Sizmar & Sainsbury, 1997).

Knowledge cannot be separated from practice and we know by doing. Student's characteristics such as their age, abilities, social economic background and prior knowledge are important considerations for the teachers in planning lesson to ensure effective teaching. An effective teacher is seen as an information deliverer, team coach, facilitator and guide who focus on challenging content. He/she is an expositor skilled with the act to break complex things into simple fundamentals and present them in a plain, simple and sequential way (Bergeron & Dean, 2013). Accordingly, the teacher should structure the classroom for individual and shared work, emphasizing both activity and collaborative work.

The teacher's knowledge and understanding of teaching is an element of their cultural, ethical, personal values, pedagogical knowledge, content knowledge and what they brought from their initial education and training and through reading and attending conferences and their reflections which are important in excellent teaching (German & O'Day, 2009). The teacher's skills, knowledge, attributes for excellent teaching is developed through experience (Carroll, 2012). This professes that teachers should constantly be engaged in the act of teaching. Constant practice of teaching could make the teacher develop more pedagogical contents knowledge and to become effective and efficient in teaching. The teacher should possess both pedagogical knowledge and detailed knowledge of the subject (Bergeron & Dean, 2013). The teacher must utilize both logical and psychological teaching methods (Dewey, 1902). The logical method

includes extensive knowledge of the topics while the psychological component is the pedagogical content knowledge. That is the approaches and practices the teacher uses to facilitate subject specific learning.

The concept or meaning of effective teaching as explained is relevant in explaining teachers' pedagogical contents knowledge since it covers all areas of teachers' professional knowledge source for effective and useful teaching. It emphasizes all the attributes of effective teachers which include adequate content knowledge, knowledge of pedagogies, and pedagogical contents knowledge. As well as knowledge of curriculum, instruction strategies and classroom structure and management.

Content Knowledge and it's Relation with Teaching Effectiveness

According to Shulman (1986), contents knowledge is a type of knowledge covering specific concepts related to the teaching topic, operations, evidences and proof and problem-solving capabilities and skills. It is the knowledge of concepts, theory for ideas, organizational frameworks, evidence and proofs in addition to established practices and approaches towards developing such knowledge (Shulman, 1987). This knowledge contains the knowledge that is learnt or taught (Mishra & Koehler, 2006). Teachers teaching certain subjects must have sufficient understanding of all the knowledge in their subjects.

Subject matter content knowledge has been described by several teacher education scholars to mean the kind of knowledge needed by the teachers for teaching (Shulman, 1986; Ma, 1999; Halim & Meerah, 2002; Vistro-Yu, 2003; Jong, 2003; Jong, Van Driel & Verloop, 2005; Rollnick, Bennett, Rhemtula & Dharsey, 2008).

Content knowledge is the concepts, principles, processes, relationships and

applications a student should know within and inside a given discipline or subject, appropriate for his/her organization of knowledge (Ozden, 2008). Guerriero (n.d) found that teachers' or instructors brings about higher better content knowledge of teachers in higher students' academic achievement. Teacher's content knowledge has an effect on both the content and the process of instruction, thus influencing both what and how they teach (Treagust, 2002). Ball and Bass (2000) carried out a study on the interweaving of content and teaching in mathematics. teaching and learning, their findings show that the subject matter knowledge needed by teachers is seen not only in the list of topics of the subject matter to be learned, but in the practice of teaching itself. This implies that knowing the curriculum content of any subject is not sufficient to justify the capability of a teacher being able to teach it. Rather, what makes a teacher capable of teaching is also how well the teacher is skilled to facilitate the learning. Hence, subject matter content knowledge can be created or developed through continuous teacher classroom practices.

Content knowledge is the knowledge one has for a specific discipline or topic (Parrotte, 2016). For example in chemistry, content knowledge in organic chemistry is the knowledge a chemistry teacher has for teaching international union of pure and applied chemistry terminology of organic compounds. Content knowledge represents the teachers' knowledge of the available programmes and curricular choices as well as all of the materials available for instruction. Of all the features of pedagogical content knowledge, content knowledge is the most easily assessed (Parrotte, 2016).

Ball, Thames & Phelp (2008) identified two categories of content knowledge as common content knowledge and specialized content knowledge. They noted that the common content knowledge is unswervingly related to what is being imparted or taught.

For example, the common content knowledge for teaching balancing chemical equation would be different from the common content knowledge for teaching isomerism in chemistry. The specialized content knowledge is the knowledge the teacher would need to teach balancing chemical equation or isomerism. Leinhardt & Smith (1985) examined the expert teachers subject matter knowledge in mathematics, using difficult topic-Fractions. They investigated subject matter content knowledge of fractions using interview and card-sorting tasks, as well as lesson observation. Their findings indicate that expert teachers were similar in their knowledge of subject matter but they differ in their classroom presentations. They argued that the difference necessitates in-service support that is tied to lesson presentation rather than independent thematic issues. Teachers having good knowledge of the teaching subject are very important for quality education (Akkoc, Ozmantar & Bingolbali, 2008; Kahan, Cooper & Bethea, 2004). Content knowledge is the knowledge of the discipline and its organizing arrangement and structure (Grossman, Wilson & Shulman, 1989; Ball, Thames & Phelps, 2008).

Content knowledge is a significant and fundamental essential for pedagogical content knowledge of the teacher (Ball et al, 2008). Halim & Meerah (2002) established that content knowledge had positive influence on pedagogical content knowledge. Teachers not having adequate content knowledge may hinder students' learning the subject very well (Aksu, Metin & Konyalioglu, 2014). Content knowledge is a technical knowledge key to the foundation of teaching as a calling and a profession (Aksu, et al, 2014). In Mathematics, Leinhardt & Smith (1985) examined the content knowledge of expert teachers in mathematics, using difficult topic-Fractions. They used methods such as interview, card-sorting tasks and lesson observation in their investigation. Their

findings indicate that expert teachers were similar in their knowledge of subject matter but they differ in their classroom presentations. Their findings also showed that teachers' mathematics knowledge influences their understanding of the lesson structure as well as the selection of examples, the formulation of explanations and demonstrations.

In addition, Isiksal and Cakiroglu (2011) explored pre-service teachers' knowledge of basic students' misconceptions with respect to the multiplication of fractions, sources of these misguided judgments and instructional strategies to defeat or overcome them. Data collection for the study was from seventeen Turkish mathematics prospective teachers. An instrument titled multiplication of fractions questionnaire was utilized in data collection in addition to semi-structured interviews. Their findings indicated that the prospective mathematics teachers experienced identified many misconceptions or difficulties that students have and the sources of the misconceptions or difficulties was from students' inadequate knowledge and rote memorization and remembrance of the logarithms.

They suggested three strategies for surmounting these misconceptions or difficulties as strategies based on instructional methods, strategies or approaches based on formal or standard knowledge of fractions and strategies/methodologies based on psychological concepts/constructs. Ogbonnaya (2011) researched the relationship between teachers' subject matter knowledge and their teaching efficacy in mathematics lessons. He used document analysis such as journal and certification to gather data to assess teachers' content and pedagogical knowledge in mathematics. His finding indicated that teachers' subject matter knowledge had positive correlation with teachers' teaching effectiveness.

In general, Ozden (2008) carried out a study on the influence of content knowledge on pedagogical contents knowledge of science teachers. The sample of the study involved 28 student science teachers. Data for the study was collected through lesson plan, content knowledge test and semi-structured interview. The findings of the study discovered that the science student teachers had basic knowledge, few misconceptions and certain inadequacies at the conceptual level. The science student teachers' had difficulties about relationships between concepts influenced by their past experiences. The findings also demonstrated that most of the science student teachers had consistent content knowledge which influenced their effective teaching practices. Hence the author concluded that content knowledge influences positively pedagogical content knowledge and effective teaching of the science student teachers.

From all indications, content knowledge is a basic factor or element of pedagogical content knowledge. Possessing sufficient content knowledge is imperative for effective teaching and students' meaningful learning. Lack of adequate content knowledge by teachers may lead to misleading students by giving them incorrect knowledge which could jeopardize their future interest in the subject. Teachers' content knowledge is therefore a very significant factor in enhancing competent teaching and learning.

Concept of Pedagogical Knowledge (PK) and it's Relation with Teaching Effectiveness

Pedagogy is the science of teaching, instruction and training (Ozden, 2008). Researchers acknowledged the fact that having knowledge of the subject or discipline is not enough to have the capacity to teach effectively. Therefore, teachers need additional knowledge of pedagogy for effective and successful teaching. Teachers' pedagogical

knowledge includes their or pedagogies as well as the organization and management of the classroom. Pedagogical knowledge is concerned with developing a classroom plan and assessment in order for students to be able to learn (Aksu et al, 2014). Parrotte (2016) defined pedagogical knowledge as the various instructional components or principles coming together, mitigated by the relational qualities of these interactions.

Pedagogical knowledge is the profound knowledge about the procedures and practices or strategies for instructing and learning and how it embraces overall educational aims, purposes and values (Koehler & Mishra, 2008). The teacher needs pedagogical knowledge in order to know in depth, the application of teaching and learning methods. Barnett & Hodson (2001) conducted a research on how to understand what science teachers know and identified pedagogical knowledge as a constituent of pedagogical content knowledge, amidst other constituents such as academic knowledge, classroom knowledge and professional knowledge.

Pedagogical knowledge includes knowledge of an understanding or comprehending of how students' learn, knowledge or fact of how to develop and implement lesson plan, knowledge of assessment of students' learning styles, techniques and general classroom management abilities and skills. According to Mishra and Koehler (2006), pedagogical knowledge entails a comprehension of cognitive or intellectual, developmental and social theories of learning and how they concern the students' in their classroom. Pedagogical knowledge comprises knowledge about the instructional methods to apply classroom teaching, the nature and characteristics of target audience and methods for evaluating students' understanding (Koehler & Mishra, 2009).

According to Cochram, Ruitter and King (1993) and Vistro-Yu (2003),

pedagogical knowledge involves teaching styles and techniques, classroom management and teaching and learning processes relating to learners in the classroom. As rightly noted by Kreber (2004), Loughran Mulhall, and Berry (2004), and Ball, Thames and Phelps (2008), pedagogical knowledge includes knowing and understanding the content to be taught and the particular demands of that content, for example, instructional abilities and strategies. A teacher's pedagogical knowledge is fundamental to pedagogical content knowledge development and advancement (Vistro-Yu, 2003; Loughran, Mulhall, and Baerry, 2004; Ball et al, 2008).

Teachers with deep or intense pedagogical knowledge understand how students create knowledge and develop skills, acquire or take up habits of mind and positive and progressive character towards learning (Aksu et al, 2014). With adequate content and pedagogical knowledge, teachers can react to students productively (Jones & Moreland, 2005). In mathematics, Voss, Kunter & Baumert (2011) found that higher pedagogical knowledge of teachers resulted in higher effective and quality of instruction.

Pedagogical content knowledge and it's Relation with Teaching Effectiveness

Pedagogical content knowledge is a blend of content knowledge and pedagogy knowledge. Therefore, $PCK = \text{Content Knowledge} + \text{Pedagogical Knowledge}$. Every one of these terms will be expatiated further to reflect their meaning. Pedagogical Content Knowledge (PCK) was coined by Shulman in 1985 when he saw a gap between pedagogy and content knowledge. He at that point presented a new category of knowledge, pedagogical content knowledge, to bridge the gap. He defined pedagogical contents knowledge as going "beyond knowledge of subject matter itself to the aspect of

subject knowledge for instruction (teaching)” (Shulman, 1986; Turner-Biset, 1999).

Shulman contended that studies and examination on teacher education and teaching disregarded inquiries that bother on content of lesson, the clarifications given and the questions asked. Shulman (1986) sees content knowledge as one understanding of the subject, while pedagogical knowledge refers to one's understanding or conception of teaching and learning processes independent of subject matter. Hence pedagogical content knowledge refers to knowledge about the teaching and learning of a particular subject matter that takes into consideration the particular learning task that is fundamental in the subject matter. Pedagogical content knowledge is the knowledge that allows teachers to make connection between their insight into instructional method and their insight into the substance. Shulman (1986), while classifying the knowledge source for teaching, maintains that the manner the subject matter is formulated and presented is critical when conceptualizing pedagogical content knowledge. Consequently, the knowledge could originate from research or teaching practice.

Additionally, Shulman's categorization of knowledge base or source for teaching included other elements such as awareness of strategies that may be fruitful in recognizing the understanding of learners' preconceptions and misconceptions concerning a certain topic. Since Shulman's definition and explanation of pedagogical content knowledge, other researchers and scholars have made varied contributions in expanding Shulman's work and proposed different conceptualizations (Grossman, 1990; Marks, 1990; Cochram, De Ruiter & King, 1993; Van Driel, Verlop, & De Vos, 1998; Magnusson, Krajcik & Borke, 1999; Gess-Newsome & Lederman, 2001; Barnett & Hodson, 2001; Halim & Meerah, 2002; Jong, 2003).

Pedagogical content knowledge is the knowledge that teachers require and utilize in the act or demonstration of teaching (Ginburg & Amit, 2008). It is the integrated synthesis or fusion of subject matter knowledge and pedagogical knowledge (Inoue, 2009). The manner the learning environment is arranged is a direct outcome of teacher's philosophy and pedagogical content knowledge on how students' reason and learn (Fler, 1999; Jones and Moreland, 2005). Pedagogical content knowledge is unique for professional or proficient teachers' since it guides and direct their activities and actions when handling subject matter/topic in the classroom (Van Driel, De Jong and Verlop, 2000). Wards (2013) identified pedagogical content knowledge as content and context specific. This means that pedagogical content knowledge varies in line with what is being taught and is unique. Pedagogical content knowledge is a particular and special body or area of knowledge which a teacher needs to effectively perform teaching in difficult and wide-ranging context (Park& Oliver, 2008; Olanipekun and Aina, 2014). A teacher needs to be capable to blend content knowledge and pedagogy when teaching. Improving performance of students requires a teacher being versatile and sound in subject matter content knowledge and pedagogical knowledge, a mix of which constitute pedagogical content knowledge. Pedagogical content knowledge is a construct that is germane in improving teacher effectiveness for better students' performance.

Numerous empirical studies on pedagogical content knowledge have been done in science subjects. Frierichsen, Abell, Pareja, Brown, Lankford & Volkmann (2009), in biology, examined biology teachers' prior knowledge for teaching. The sample of the study comprised four respondents seeking biology certification. Two of the respondents had two years of past biology teaching experience. Data for the study were collected

using lesson preparation method. Participants were asked to write out lesson plans on the meaning of heritable variation in biology. Primary data was collected through lesson plan and interview. The result of the study revealed that both groups of participants held didactic teaching orientations. Finding further showed that they wrote similar lesson plans. The two groups drew on fundamental or basic pedagogical knowledge and had minimal pedagogical content knowledge for teaching hereditary difference. The finding likewise discovered that showing background had little contrast, prompting more reconciliation among instructive learning parts.

Another empirical investigation by Park and Chen (2012) done using a four biology teachers working in one high school with similar curricular materials. Data for the study were collected from primary sources namely lesson observations, instructional materials and work books. The result of the research demonstrated that the integration of the component idiosyncratic or individual and topic-specific. Findings further showed that learning of students' understanding and knowledge of instructional techniques/strategies and representations were important in the integration. Knowledge of science curriculum and knowledge of assessment of science learning was all the more frequently associated with knowledge students' understanding of instructional methods/strategies and representation than with different or other components. Findings of the study also revealed that didactic or informative inclination toward teaching Science focused knowledge of teaching strategies and representation, inhibiting or hindering its connection with other components. The authors established that the quality of pedagogical content knowledge rest on the consistency among the components along with the quality and strength of the individual components.

Another study in biology by Lucero, Petrosino, & Delgado (2016), their study explored the relationship between science teachers' subject matter/topics knowledge and knowledge of students' conceptions of evolution and development by natural determination or selection. The sample of the study consists of four biology teachers at a single high school. Data collection for the study was from primary sources such as classroom observation and interview. The interview was conducted on subject matter knowledge of the teachers and students' responses using Conceptual Inventory of Natural Selection (CINS). The finding of the study indicates relative independence between subject matter/topic knowledge and knowledge of student understanding or conceptions.

In physics, Kim and Alonzo (2015) examined teachers' pedagogical content knowledge using a sample of six physics teachers teaching a topic force and motion. Primary sources such as video-based interview were used for data collection for the study. The physics were made to respond to video clips. The findings revealed that all the six teachers established the key components of their declarative pedagogical content knowledge steadily across the two interviews. The findings also established that the teachers relied more on their declarative pedagogical content knowledge as they thought through new examples of students thinking and relating to instructional reaction or responses. Teachers' differed in declarative and dynamic pedagogical contents knowledge.

Additionally, study in mathematics was conducted in Germany by three mathematicians Krauss, Baumert & Blum (2008) to evaluate the differences between teachers that were trained and qualified to carry out teaching at the academic track and teachers teaching in other types of secondary schools. The study sample involves of

ninety-eight teachers of mathematics. The questionnaire on pedagogical content knowledge and content knowledge was used to draw data and interview was employed to collect qualitative data from the participants. The pedagogical content knowledge in knowledge of students' misconceptions, knowledge of teaching methods/strategies, and knowledge of mathematics tasks/assignment were assessed. Their findings established that teachers at the academic tasks scored higher statistically than others in knowledge of mathematical tasks. They concluded that mathematics and science need a high level of common content knowledge, specialized content knowledge and pedagogical content knowledge for quality instruction.

Furthermore, in mathematics Ball and Bass (2000) conducted a study on the interweaving of content and pedagogy in the teaching and learning mathematics. Their findings showed that the subject matter knowledge needed by teachers is discovered not just in the list of topics of the subject matter to be learned, but in the practice of teaching itself. This finding is also in consonance with that of Plotz, (2007). The implication of their findings is that knowing the content of a subject is not sufficient to justify the capacity of a teacher to effectively teach. Rather, the thing that makes a teacher capable of teaching is also how well the teacher facilitates the learning. The authors argue that little is known concerning about the way or manner by which 'knowing' a topic from a list of topics influences teachers' capabilities. They emphasize that if one depends on analyzing the curriculum to identify the subject matter content knowledge needed for teaching the topics without focusing on practice as well, not much will be gained (Ball & Bass, 2000; Plotz, 2007). In addition, Ijeh (2012) investigated mathematics teachers pedagogical content knowledge competence in statistics teaching. The study conducted in

mathematics by Plotz (2007) cited in Ijeh (2012) indicated that subject content knowledge and pedagogical knowledge are all needed for effective teaching and can motivate the development or creation of pedagogical content knowledge to be used for teaching. Plotz emphasizes that teachers' previous knowledge requires exposure for effective content knowledge transformation and understanding as the prior knowledge aids the teachers in the written problem-solving activities to design and to assess their subject content knowledge state.

Aksu, Metin and Konyalioglu (2014) carried out an investigation aimed at developing a scale to determine the pedagogical content knowledge of pre-service teachers'. The sample of their study was obtained from different Faculties of Education of different universities in Turkey. A sample of 798 pre-service teachers were utilized in their study. Interview, seeking experts' opinion and essay writing on pedagogical content knowledge were the instruments for data gathering. 20 teachers and 15 pre-service teachers were requested to write essay linked to pedagogical content knowledge. Through their responses and expert opinion and reviewed literature, the researchers developed a pedagogical content knowledge scale consisting of 38 items. The items were validated and its' internal consistency established as 0.96. The instrument having been validated by experts and reliability established, can be equated to a standard instrument hence the researchers presumed that it was ready for use. This instrument was adapted to be used for this present investigation.

Olfos, Tatiana and Soledad (2014) conducted a study on teachers' pedagogical contents knowledge in connection with students' understanding. The study sample embraced 53 mathematics teachers teaching 1532 students. They studied the content and

pedagogical content knowledge of the mathematics teachers teaching these students. The teachers teaching experience, mathematical preparation and socioeconomic status of the schools where the study was conducted were quantified. The finding revealed that teachers' content knowledge had a significant link with students' learning and less significant than the association with experience. The finding further revealed that socioeconomic factors were strongly connected with students' academic achievement.

In chemistry, De Jong, Van Driel & Verloop, (2005) investigated the pedagogical content knowledge of pre-service chemistry teachers utilizing particle models in teaching. The study sample involved of twelve master's degree pre-service chemistry teachers who were part of an experimental introductory course module on how to use particle models to assist students' of secondary school to understand the association or connection between phenomena. The emphasis was learning by teaching and connecting authentic teaching experiences with institutional workshops. Primary sources were used for data collection. These sources are answers from written tasks/assignments, transcripts or records of workshops deliberations and reflective lesson report. The finding of the study indicated that all the participants (students) were able to describe specific learning difficulties initially. Such learning difficulties like the difficulties or challenges students of secondary school have in explaining the properties of element or substances to the features of the component particles. After receiving a special education connected to pedagogical content knowledge, all the pre-service chemistry master student teachers demonstrated a deeper understanding of their students' understanding problems with the use of particulate nature of matter. The findings also demonstrated that six of the teachers have turned out to be more mindful of the possibilities and limitations of the utilizing a

particle models in a particular teaching situation, through learning from teaching. The pre-service teachers further developed their pedagogical contents knowledge in varying degrees through the help of macro, micro and symbolic meanings related to chemistry topics.

Still in chemistry, Bond-Robinson (2006), ascertained the pedagogical content knowledge development of twelve graduate students in the chemistry laboratory. The study sample consists of twelve graduate students. Lesson observation was the method of data gathering from the participants. The findings indicated that graduate students developed pedagogical content knowledge through giving a laboratory talk at the start of a class, through weekly seminar discussion among peer, and through modelling of teaching from advanced peer.

Components of Pedagogical Content Knowledge

Shulman (1987) recognized seven classes of basic knowledge for teachers as: contents/topics knowledge, general or basic pedagogical knowledge, pedagogical content knowledge, curriculum/programme knowledge, knowledge of educational settings or contexts, knowledge of students/learners and their attributes, knowledge of educational goals. These seven categories of knowledge constitute essential knowledge in teacher preparation programmes.

Grossman (1988) defines pedagogical content knowledge based on four central components; namely, knowledge of learners' understanding; the curriculum; instructional methods and the aim of teaching. Knowledge of learners' understanding refers to how the learners' grasp what is imparted or taught (Ijeh, 2012). This suggests how learners see and comprehend the topic introduced to them by the teacher in the classroom. The

curriculum concerns the content of the subject matters as contained in it. Knowledge of instructional strategies implies understanding the strategies or procedures employed in teaching the subject. At that point the goal or motivation behind teaching is to ensure that the learning outcomes outlined in the curriculum are achieved.

Grossman (1988), utilizing these components, analyzed impact of teacher education on knowledge development and discovered that teacher education impacts on knowledge development by teachers. Grossman (1998) notes that the education of teachers can make available an opportunity for them to gain more knowledge and growth, if they keep on practicing in the particular subject or discipline. In addition, Clermont, Krajcik and Borko (1993) asserted that pedagogical content knowledge involves an understanding of student's experience, developmental age, social economic status and the previous knowledge that students carry with them in the learning of a specific topic, knowledge of materials to use and how to sequence those materials to acquire new concepts and skills and the knowledge of what makes the learning of those topics easy or difficult to students and how teachers apply teaching skills in bringing about changes in students' learning through interaction and engagement.

Hence Clermont et al (1993) described pedagogical content knowledge as a “mixture of contents and pedagogy that provides teachers with an understanding and perception of how a particular subject-matter topic, challenges and issues sorted out represented and modified, to the different interest and capabilities of learners and afterward, presented for instruction” (p. 21). The work of Magnusson, Krajcik & Borko (1999) demonstrates that numerous factors can be utilized to explain pedagogical content knowledge. The variables are subject matter knowledge (substantive knowledge and

syntactic knowledge), pedagogical knowledge and knowledge of educational goals, knowledge of the classroom and content knowledge including knowledge of specific learners' and school characteristics. The study by Halim & Merah (2002) identified knowledge of ways of representing particular ideas or concepts in order to facilitate learning to interpret pedagogical content knowledge. Bond-Robinson (2005) view pedagogical content knowledge as integrative of pedagogy knowledge and subject matter content knowledge needed for successful teaching in ones' area of specialization or discipline.

According to Bond-Robinson (2005), pedagogical content knowledge is craft knowledge, attained from teachers' previous education, the teacher's personal background, and the teaching contexts and through experience in the “doing” of teaching. From this point of view, plainly teachers develop pedagogical content knowledge from their initial training or preparation and their active participation in the practice of teaching.

According to Rollnick, Bennett, Rhemtula, Dharsey and Ndlovu (2008), these domains can be combined in the teaching process to provide effective teaching and promote learners' insight and comprehension of the lesson. Researchers like Jong (2003) and Van Driel et al,(1998) maintain that certain elements appear to be germane to any conceptualization of pedagogical content knowledge as regards chosen content area. These elements are: knowledge of learners' learning difficulties, conceptions and misinterpretations or misconceptions regarding the subject matter or topic; and knowledge of exactly how to represent particular subject matters or topics.

Consequently, Bucat (2004), and Mitchell and Mueller (2006) contend that a

teacher's pedagogical content knowledge is unique since it depends on how the teacher interprets learners' preconceptions and learning difficulties and what the learners' need in order to understand the subject matter being taught. According to Henze, Van Driel and Verloop (2008), the creation of pedagogical subject matter or content knowledge is mutual and hence the development of one component influences the development of another. Hill, Blunk, Charalambous, Lewis, Phelps, Sleep & Ball (2008) found that a significant relationship existed between a teacher's pedagogical content knowledge and what he/she does in the classroom. They contended that the improvement of a teacher's pedagogical content knowledge is established in the classroom and this may well contribute to effective and efficient teaching.

Components of PCK for Teaching Chemistry

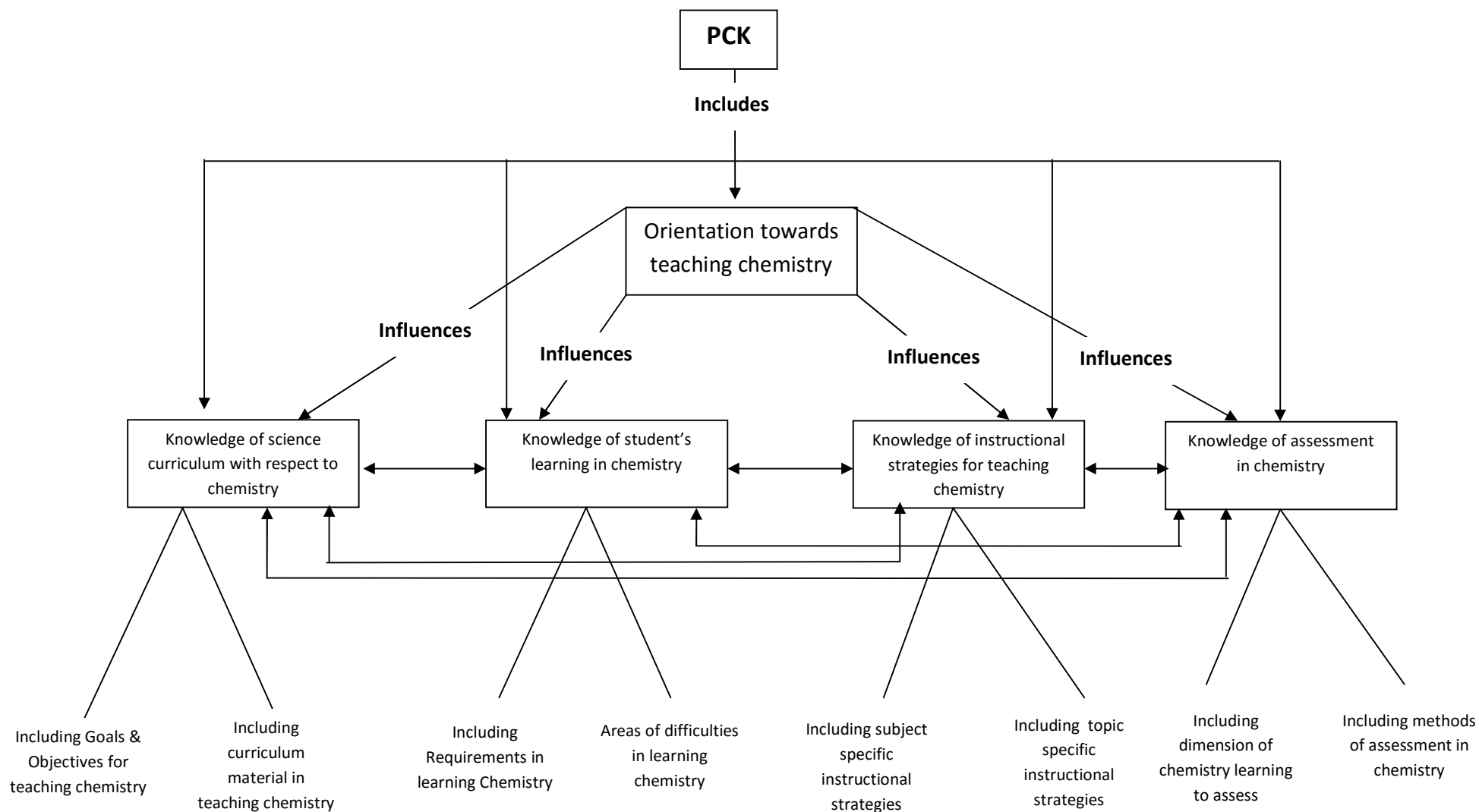


Fig 1: Knowledge components of PCK for teaching Chemistry.

Source: Adapted from Magnusson et- al, 1999: 99.

The Figure 1 clearly shows the components of pedagogical content knowledge for teaching chemistry. From the figure, chemistry teachers receive orientations for instructing or teaching the subject through formal training in the higher institutions of learning. Such orientations influence the teachers' knowledge of chemistry curriculum, knowledge of students learning, knowledge of instructional techniques and strategies for teaching chemistry and knowledge of assessment techniques for assessing learners learning in chemistry. Knowledge of chemistry curriculum includes the teacher's knowledge of the aims and objectives for teaching chemistry and knowledge of curricular materials suitable for teaching chemistry. Knowledge of students learning in chemistry includes teachers knowing the requirements for teaching chemistry as well as knowing the areas of students' learning difficulties. Knowledge of instructional strategies for teaching chemistry includes teachers' knowledge of subject specific instructional methods and topics, specific instructional strategies. Knowledge of evaluation in chemistry involves the teachers' knowledge of dimensions of learning to assess and knowledge of methods or techniques of assessment in chemistry.

Importance of Teacher's Pedagogical Content knowledge

Pedagogical content knowledge is an essential factor or element for teachers to conduct effective and efficient teaching. The importance of pedagogical content or subject matter knowledge in instructing or teaching of any science subject has long been researched and established. Griffik, Dodds and Rovengno (1996) maintained that teacher's pedagogical content knowledge is specific or peculiar to teaching and distinguishes between expert teachers in a specific subject area and non-subject area experts. Pedagogical content knowledge interrelated with students' achievement or

success in a positive and better way (Carpenter, Feneme, Peterson, Chang & Loef, 1989; Rovegno, 1992; Aksu et al, 2014). Teachers with strong pedagogical content knowledge focus on their students' thinking and understanding, they make appropriate explanations for their cognitive levels, they present contents which consider students' needs and utilize many teaching strategies more accurately (Gudmundsdottir, 1990; Wilson & Winwberg, 1989).

Pedagogical content knowledge gives prospects for teachers with knowledge on teaching exercises and activities, the programme standard, teaching method and schools, students and society or public transfer to students (Griffin, Dood & Rovegno, 1996). Pedagogical content knowledge offers knowledge about how subject titles, problems and their results are organised, presented and modified (adapted) into students' skills and interest (Clemont, Krajcik & Borko, 1993). When pedagogical content knowledge is investigated in totality, it is an imperative antecedent for teachers to enhance themselves from a trainee or learner executive to a professional executive (Clemont, Krajcik & Borko, 1993).

Teacher's Pedagogical Content Knowledge and Quality Teaching

Lots of studies have emphasized the importance of teacher's pedagogical content knowledge in enhancing quality teaching. For example, Shulman (1996) emphasized that pedagogical content knowledge makes a difference for instructional quality and students' learning. Study conducted by Baumert et al (2010) revealed that a significant positive relationship existed between a teacher's content knowledge and pedagogical content knowledge on instructional quality. The result of Kunter, Klusmann, Baumert, Richter, Ross and Hachfeld (2013), showed that pedagogical content knowledge had greater

predictive power for students' progress and instructional quality. Their findings further indicated that teachers' pedagogical content knowledge had a positive influence on students' motivation.

Hence Evens, et al (2015) remarked that to enhance the quality and value of education, there is need to invest on prospective teachers' pedagogical content knowledge. The importance of pedagogical content knowledge in enhancing the quality and worth of instruction and students' learning and outcomes cannot be over emphasized.

Pedagogical Content Knowledge and Knowledge of Instructional/Teaching Skills

Instructional strategies can be taken to mean approaches adopted by the teacher during teaching-learning procedures that ensure that classroom practices become more learner-friendly to enhance students' productive learning. Ijeh (2012:35) defines pedagogical knowledge based on the kind of information that a teacher needs and uses to perform everyday teaching tasks. Instructional knowledge encompasses knowledge of how to sequence the learning outcomes, knowledge of lesson preparation, and knowledge of how to facilitate discussion and group work, knowledge of how to construct tests and evaluate learners' understanding through the use of examinations, among others (Kreber, 2004). Different kinds of instructional strategies, representations and activities are used in the teaching of chemistry.

Innovative instructional strategies such as concept mapping, problem solving, team teaching, cooperative learning, and focus group discussion are effective for teaching of chemistry. Knowledge of instructional techniques and strategies entails understanding ways of representing specific concepts in order to facilitate students' learning. Such representations include demonstration, illustration, giving examples, use of models and

analogies during chemistry lessons. According to Ibeawuchi (2010), each representation has a conceptual merits and demerits over other representations. Therefore, pedagogical content knowledge in this context includes awareness of comparative strengths and shortcomings of a particular representation.

Activities during chemistry lessons involving simulations, investigations, observations, demonstrations, recordings, interpreting data, experimentations and measuring can be utilized to aid students to comprehend particular concepts or relationships. Representations during instruction or teaching need be clearly related and the connections between concepts/ideas must be comprehensive (Ibeawuchi, 2010).

Research conducted by Hashweh (1987), while linking instructional strategies with pedagogical content knowledge, emphasized that incorrect and misleading representations such as analogies and examples that depict the learners' misrepresentations, could result from teaching outside one's own field of expertise. When teachers teach outside their areas of specializations, they give explanations and analogies that reinforce the misconceptions that learners already have.

It has been debated by Magnuson, Krajcik & Borko (1999) that pedagogical content knowledge is dependent on teacher's content knowledge about a particular concept. Other researchers example Darling-Hammond and McLaughlin (1996) contend that the above contention by Magnusson may not always be true for the fact knowledge of the subject matter does not ensure that pedagogical content knowledge will be transformed or modified into representations that will help learners to understand targeted concepts or that teacher will be able to decide when it is most appropriate pedagogically to use a particular representation.

Supporting this view, Anderson & Mitchener (1994) maintain that science teaching may be limited, even if teachers have knowledge of the subject matter. Halim & Meerah (2002) note that in a particular topic, pedagogical knowledge or the way concepts are presented as a component of pedagogical contents knowledge, appears to rely on previous preparation, reflection and teaching.

Studies by De Jong, Van Driel and Verloop (2005) and Rollick, Bennette, Rhemtula, Dharsey, and Ndlovu (2008) on pedagogical content knowledge indicate that science teachers with adequate pedagogical knowledge should be able to design good teaching and learning strategies that allow them to teach the concepts and manage the classroom and other instructional and learning processes.

Assessing Teachers' Pedagogical Content Knowledge in Chemistry

Several researches have been done on how to assess science teachers' PCK. Jong's (2003) study on how to measure science teachers' instructional skills and strategies suggested the use of multi-method approach in exploring knowledge of the relevant instructional strategies during classroom practices. This multi-strategy evaluation of science teachers' pedagogical (instructional) knowledge involves collecting multiple sources of data. Although it has been proven (Gess-Newsome and Lederman, 2001) that the use of multi-method analysis tends to create increasing impact on changing knowledge with each data source, thereby adding more dimensions to the findings from another source, and thus biasing the findings of the study, other researchers have used the multi-strategy approach with increasing success. The multi-method approach involves the use of classroom observation of particular chemistry teachers. Lesson observation is a process of gathering open-ended first hand information by observing the participant

physically and gathering the information as it occurs at the site of the study or research (Cresswell, 2008). Lesson observation has the advantage of studying the actual behaviour of the participants and the difficulties they may have in demonstrating their ideas during research activities. It also affords firsthand information and recording the actual behaviour of the participants at the research site.

Another multi-method is the use of teachers' written report to evaluate PCK during classroom practices in the sciences (Gess-Newsome and Lederman, 2001; Penso, 2002; Jong 2003; Capraro, Capraro and Parker, 2005). The use of teachers' written report has the advantage of making teachers reflect on their teaching, thereby providing opportunities for the teachers to evaluate it. The capacity to reflect is an essential quality of an effective and efficient teacher (Borko, Michalee, Timmons & Siddle, 1997; Posner, 1996).

Another strategy that has been utilized to assess pedagogical knowledge in the context of pedagogical content knowledge development is the questionnaire (Gess-Newsome & Lederman, 2001 and Vistro-Yu 2003). Gess-Newsome & Lederman (2001) were able to capture what the teachers did while teaching a specific topic in science and mathematics. The questionnaire was employed to evaluate what the science teachers did while teaching the assigned topics. Science-free response questionnaire was used to obtain the teachers' feelings about their actions all through the study or lesson which they might not have displayed or expressed during the lesson and interview. In addition, document analysis has been used to assess science teachers' pedagogical knowledge. Capraro, Capraro, Parker, et al (2005), Jong Van-Driel and Verloop (2005) and Ogbonnaya (2011) investigated the relationship between teachers' content knowledge

and their teaching effectiveness. They used document analysis such as journal and certification to gather data to assess teachers' content and pedagogical knowledge in mathematics and they were successful. In their study, the teachers analyzed documents such as teachers' portfolios, learners' workbook and portfolio, textbooks and school policy guidelines for teaching and learning. These documents were described as having the advantage of being readily available for reading, analysis and interpretation by the researcher. Their finding indicates that teachers' content knowledge has positive relationship with teachers' teaching effectiveness.

The usage of video or audio-virtual recording of lessons has been used to assess pedagogical knowledge of teachers. Jong (2003) used this method and found that teachers are able to explain their cognition in detail while they look at a video record of a lesson that has been taught. The disadvantage of this method is its distracting nature, although it helps teachers to recollect what they had taught during the lesson, as well experiencing how the lesson was delivered.

Strategies for Improving Chemistry Teachers' Development of Pedagogical content knowledge

Chemistry teachers are trained at Faculties of Education in Nigerian universities. Some even entered the teaching profession with Nigeria Certificate in Education. More still, some chemistry teachers gain entry into the teaching profession without possessing an education degree in Chemistry. That is, these categories of teachers enter the teaching profession with a Bachelor of Science degree or just after a Postgraduate Diploma in Education Programme. Whatever the pathway through which the chemistry teachers enter the teaching profession in Nigeria, all of these chemistry teachers need professional development. A lot of strategies can be used for enhancing chemistry teachers

pedagogical content knowledge. These strategies are outlined by the UN National Academies, as follows:

- i) University-based initiatives ·
- ii) Government sponsored programmes ·
- iii) Privately sponsored programmes

University-Based Initiatives: This involves universities taking up the challenges of helping to solve the problem of improving student learning outcomes in chemistry by organizing chemistry education conferences yearly or every two years.

These programmes are aimed at increasing chemistry teachers' content knowledge, as well as providing laboratory experiences. As a way of encouraging teachers to participate in such programmes, stipend should be attached to attendance and it should be used as promotion criteria. Teachers' professional development should be linked to students learning in an educational environment setting with a specific end goal to influence genuine school change (Guskey, 1997). Newman et al (2001) contend that “professional development is more likely to advance achievement of all students in a school if it addresses not only the learning of individual teachers, but also different aspects of the organizational ability of the school”.

Garet, Porter, Desimonen, Birman and Yoon (2001) conducted a study examining the effects of different features of professional development on teachers' learning by examining a large national sample of teachers of Science and Mathematics.

Their findings indicated three core features that positively influenced teachers' skills, knowledge and change in classroom preparation as focus on content knowledge,

opportunity for active and dynamic learning, and consistency with their learning activities. Their findings also indicated that organizational factors like the form of the activity, collective participation, as well as duration of the activity have indirect effects on teachers' learning through these core or fundamental factors. Penuel, Fishman, Yamaguchi & Gallagher (2007), building on the findings of Garet et al (2001:2), included the role and function of context/setting as imperative consideration in science education. These contexts include elements such as school philosophy, prioritization of initiatives, planning time, and presence or availability of materials, stressing that these contextual elements can impact a teacher's utilization of a new invention or innovation. Therefore, institutions should incorporate these elements when in their professional development and training programmes for science teachers. Studies conducted in the United State of America and abroad, Darling-Hamond, Chung Wei, Andree, Richardson and Orphanos (2009) found that professional development and advancement is most effective and efficient when it is intensive and continuous over a lengthy period of timeframe, includes participants in cooperative learning and permits teachers to be involve in school decision making. Teacher's training is acknowledged as foundation through which teachers attain and develop pedagogical content knowledge for good teaching (Lim-Teo, Chuo, and Cheang, 2007).

Government Sponsored Programmes: Government sponsored programmes can take varied forms. The United State of America government has used forms such as programmes operated by the National Science Foundation, National Institute of Health and the Department of Energy Office of Science to sponsor programmes which focused on increasing the content knowledge of chemistry teachers that provide background for

implementing inquiry-based learning. The Department of Energy employed its national laboratories as a means for chemistry teachers to have up hands on research and investigation experience.

Privately Sponsored Programmes: Private individuals and organizations can organize educational programmes in chemistry education where teachers can participate for the purpose of improving their content knowledge and pedagogical knowledge. In the United States of America, so many in-service programmes are being organized through different outreach programmes for teachers. For instance, Bayer Corporation: making science make sense, ASSET: (Achieving Student Success Through Excellence in Teaching), Hach Scientific Foundation, American Chemical Society Summer Workshop, are some of the outreach programmes owned by private individuals for empowering science teachers for increasing content knowledge and pedagogical knowledge.

Professional development and in-service programmes are intended to encourage the growth and development of teachers that may be employed for their development (Crowther 2000). Professional development provides chemistry teachers opportunities for active learning and content knowledge. Effective professional development and has made knowledge base that has transformed and rebuild quality schools (Guskey, 1995; Willis, 2000). Mayotte, Wei, Lamphier and Doyle (2013; Sharma, 2016) explaining how professional development is related to school change, maintain that change from professional development requires tolerance and perseverance, that instructors or teachers need to comprehend this transformation process and assess the factors affecting it. Researches have endeavored to clarify what constitutes effective professional development for science teachers and how professional development works to improve

students' learning (Desimone, 2009; Wallace, 2009; Louck-Horsley and Matsumoto, 1999). Teachers' pedagogical content development and growth can be by way of long term programmes (Vale, 2010 and Vale et al, 2011). An investigation by Guskey and Sparks (1996) suggests that multiple elements influence the quality of professional development and its impact on student learning. Such factors or elements are programme content, structure and format of delivery and the context in which implementation occurs.

In an all-inclusive review on professional development by Darling-Hammond, et al., (2009), they found that professional development is best most effective when it is intensive and continuous over a lengthy period of timeframe, and that it involves participants in cooperative learning and permits teachers to be involve in school decision making. Lucilio (2009) found that professional development of secondary school teachers was most effective and efficient when it is implemented or applied in school-wide delivery involving all-day sessions. They study further showed that methods like hands-on participation and demonstration are the most beneficial in-service methods, as well as training and mentoring being the most likely methods of improving teacher performance.

The National Research Council (1996) claimed that effective professional development would:

- Provide opportunities for teachers to learn and use various tools and techniques for self-reflection and collegial reflections.
- Provide opportunities for teachers to receive feedback about their teaching and to understand, analyze and apply the feedback received to improve their practice.
- Provide regular, numerous prospects for collegial and individual

examinations and reflection on instructional and classroom practice.

- Provide opportunities or means for teachers to acquire and use the skills of investigation to gather new knowledge of science and the teaching and learning of science .
- Support the sharing of teacher expertise by preparing and using mentors, coaches, teacher advisers to provide professional development opportunities (p.8).

Professional Learning

Professional learning is another method that can be used to improve chemistry teacher's pedagogical content knowledge. Professional learning is described as a process wherein teachers work under the supervision of experts to enhance their professional practice and increase their knowledge or insight of the school subjects they teach (Brimoh & Okedeyi, 2001). According to Darling-Hammond and McLaughlin (1996:203), professional learning is “deepening teachers' understanding about the teaching/learning process and the students they teach must start with pre-service training and proceed all through a teacher's career”. Professional learning is the responsibility of qualified teachers to constantly enhance their teaching practice (Goodrum & Hackling, 2003).

The National Commission for Science and Mathematics Teaching, NCSMT (2000), described professional learning as a “planned, collaborative, education process of continuous improvement and development for teachers that assistance them develop their knowledge and insight into the subject(s); improve their teaching skills in the classroom; hold on to developments in their fields, create and contribute new fact or knowledge to

their profession, increase their capacity to monitor students' work so they can give valuable feedback to students and properly redirect their own teaching” (p.18). In this manner, through professional learning chemistry teachers acquire the knowledge, competence and skills required for teaching successfully and enhance their professional potentials and practice and in this way, teacher’s pedagogical content knowledge could be improved.

Chemistry teachers need professional learning opportunities where they can collaborate with their colleagues and experts on how to improve their teaching skills, curriculum delivery, and classroom management and gain deeper understanding of procedures for evaluating learning outcomes of students. Investigations have revealed that collaborative learning (Leikin (2004) and working in professional community (Dalgarno & Colgan, 2007) can help improve teacher’s pedagogical content knowledge.

Mentoring

Mentoring is another method of enhancing teacher’s pedagogical content knowledge. and investigations have demonstrated that mentoring can help improve teachers' advancement in teaching (Schulz, 1995; Dreher & Ash, 1990; Colvin & Ashman, 2010). Teachers can learn and develop new perspectives and novel methods of teaching. Through peer mentoring, college and university teachers learn and gain from one other innovative instructional techniques/strategies that can aid the improvement of their instructional practices and students' learning academic success and outcomes. Good, Halpin & Halpin (2000) demonstrated that teachers who were mentored by experienced teachers enriched their scholastic or academic skills, pedagogical practices and content knowledge, and in addition self-confidence and verbal abilities and skills. Studies by

Hafner, Moffatt and Kisa (2011), Terrion and Leonard (2011); Nilssen, (2010); Packard (2003), Jacobi (1991) and Redmond (1990) propose that mentoring influences career development, supports student retention and achievement, enhances teachers instructional practices, professional growth and academic development and influences social skills development.

Ofovwe & Agbontaen-Eghafona (2011) studied mentors and mentoring amongst academic staff in Nigerian higher institutions using University of Benin, Edo State. The findings of the investigation demonstrate that senior staffs normally were more comfortable with the principles of mentoring and are more probably to mentor others for improved employees' or staff performance. The study established that mentoring is imperative for promoting or fostering a culture improved academic standards of performance. Hence, it was recommended that mentoring in the academic community should be formalized as a reasonable way or method for stimulating professional development and employees' performance. Ofobruku & Nwakoby (2015) directed an investigation on impacts of mentoring on employees' performance in selected family business in Abuja, Nigeria. The study utilized a survey research design making use of both qualitative and quantitative approaches. The study population was the construction industry in Abuja. A sample of 367 employees of construction industries in Abuja were randomly selected for the study. The data collected were analyzed using Pearson correlation coefficient statistics. The result of the study indicated that mentoring had positive impacts on employees' performance. Career support had higher positive impact on employees' performance than psychosocial support.

Other strategies that have been identified for the development of teacher's

pedagogical content knowledge include field experience (Strawbecker, 2005 & Karp, 2010), provision of supportive working conditions (Dalgamo & Colgan, 2007), lesson study approach (Sibbald, 2009) and through reading various textbooks in one discipline (Davis, 2009).

Appraisal of Reviewed Literature

This chapter reviewed elaborate literature on studies conducted on pedagogical content knowledge in different subject areas. From the review, majority of the studies conducted on pedagogical content knowledge covered mathematics. And most of these studies were done in developed countries. In addition, the sample used for these international studies were majorly pre-service teachers. Most of the studies pedagogical content knowledge in mathematics focused on identifying learners' misconceptions and instructional strategies/ methods to surmount them. These studies revealed that pedagogical content knowledge enhancement or development of teachers is a classroom affair. The implication of this statement is that teachers' enhanced development of pedagogical content knowledge is dependent on the extent to which teachers exercise teaching in real classroom situation.

All the studies reviewed in this chapter were carried out in countries outside Nigeria. To the best of the knowledge of the researcher, in Bayelsa and Delta States, studies or researches have not been conducted on pedagogical content knowledge chemistry teachers in connection to teaching effectiveness. Moreover, most of the studies or researches reviewed in this chapter covered other science subjects like mathematics, physics and biology. Again, of the studies looked into in chemistry in this chapter, most

of the samples for the study were drawn from pre-service teachers. However, studies on the strategies for enhancing the development and enhancement of pedagogical content knowledge among chemistry teachers were scanty. This study intends to fill the knowledge gap by examining chemistry teacher's pedagogical content knowledge and teaching effectiveness in Bayelsa and Delta States

CHAPTER THREE

RESEARCH METHOD AND PROCEDURE

This chapter is concerned with the research method and procedure that will be adopted in conducting the study. It describes the Research Design, Population of the Study, Sample and Sampling Techniques, Research Instrument, Validity of the Research Instrument, Reliability of the Instrument, Administration of the Instrument and Method of Data Analysis.

Design of the Study

This study is a survey research of the co-relational design. It used a collection of qualitative and quantitative sources of data collection from the respondents. The primary data collection source involved the checking of chemistry teachers' lesson notes and classroom observation. This was facilitated by the use of classroom observation guides. The respondents were free to express themselves and thus give a vivid description of the phenomenon being investigated. The quantitative data involved the use of structured questionnaire to solicit responses from the respondents.

Population of the Study

The entire population of this study comprised all the chemistry teachers, principals and chemistry students in public senior secondary schools in Bayelsa and Delta States of Nigeria during the 2016/2017 academic year. There are one hundred and seventy-six (176) public senior secondary schools in the three senatorial districts of Bayelsa State and three hundred and twenty-seven (327) public senior secondary schools in the three senatorial districts of Delta State. Bayelsa State has ninety-seven (97) chemistry teachers and 176 principals while Delta State has five hundred and sixty-four

(564) chemistry teachers and 327 principals as at 2016 (Bayelsa State Ministry of Education & Delta State Ministry of Education). Tables 1 and 2 show the population of senior secondary school teachers in Bayelsa and Delta States as at March and February, 2016 respectively.

Table 1: Population of Senior Secondary Schools in Bayelsa and Delta States having Chemistry Teachers

Senatorial Districts	Local Govt. Area	No. of Schools	No. of Principals	Male Teachers	Female Teachers	Total No of Teachers
BAYELSA STATE						
Bayelsa East	Barass	10	10	2	4	4
	Ogbia	32	32	6	5	9
	Nembe	15	15	6	4	10
Bayelsa South West	Ekeremor	21	21	7	5	12
	Sagbama	24	24	9	4	13
	Silga I & II	31	31	7	5	12
Bayelsa Central	Yenagoa	33	33	17	10	16
	Kolokumor	10	10	3	3	6
Total	8	176	176	57	40	97
DELTA STATE						
Delta North	Aniocha North	12	12	12	3	15
	Aniocha South	15	15	8	11	19
	Ika North East	16	16	22	16	38
	Ika South	17	17	20	7	27
	Ndokwa East	9	9	8	6	14
	Ndokwa West	15	15	11	5	16
	Oshimili North	10	10	13	8	21
	Oshimili South	9	9	16	12	28
	Ukwani	13	13	13	7	20
	Ethiope East	16	16	19	8	27
Delta Central	Ethiope West	16	16	8	14	22
	Sapele	17	17	21	15	36
	Udu	12	12	6	23	29
	Okpe	15	15	12	12	24
	Ughelli North	39	39	41	33	74
	Ughelli South	19	19	12	11	23
	Uvwie	15	15	24	31	55
	Bomadi	3	3	3	1	4
	Burutu	4	4	4	0	4
	Isoko North	14	14	13	3	16
Delta South	Isoko South	14	14	8	8	16
	Patani	4	4	3	1	4
	Warri North	8	8	3	7	10
	Warri South	12	12	10	9	19
	Warri South West	3	3	1	2	3
		25	327	327	311	253

Source: Bayelsa and Delta States Ministry of Education (March 2016).

Sample and Sampling Techniques

First eighty secondary schools having chemistry teachers were selected using purposive sampling technique from the three senatorial districts each of the two states. The use of purposive sampling technique was as a result of the difficulty in reaching all the population of schools in the two states. Thus, 20 schools for Bayelsa and 60 schools for Delta were sampled. Then, using simple random sampling technique, 50 out of the 97 chemistry teachers in Bayelsa secondary schools were selected from the three senatorial districts. While 179 out of 564 chemistry teachers in Delta State secondary schools were selected from the three senatorial districts. The use of random sampling was informed by the ease of getting a representative sample of the population of teachers in the two states. In addition, random sampling is a straightforward probability strategy of sampling and can help to eliminate bias for the procedure of selection. The sample selected represented 51% from Bayelsa State and 32% from Delta State respectively. Principals of all the schools selected using stratified sampling technique in Bayelsa and Delta States were used for the study. They were 80 principals (20 Bayelsa and 60 Delta) during the 2016/2017 academic session. The chemistry students, 480 (240 boys & 240 girls) were selected using simple random sampling technique from SS3 class. The overall sample of the study is seven hundred and eighty-nine (789). The breakdown of the total sample of the study is chemistry teachers = 229, principals = 80 and chemistry students = 480.

Table 2: Sample of Chemistry Teachers Selected from Bayelsa State

Senatorial Districts	LGA	Male	Female	Sample of Chemistry Teachers Selected		Total Sample Selected
		Chemistry Teachers	Chemistry Teachers	Male	Female	
BAYELSA EAST	Barass	2	4	1	2	3
	Ogbia	6	5	3	3	6
	Nembe	6	4	2	1	3
	Ekeremor	7	5	4	2	6
BAYELSA SOUTH WEST	Sagbama	9	4	5	2	7
	Silga I & II	7	5	3	2	5
BAYELSA CENTRAL	Yenagoa	17	10	10	6	14
	Kolokumor	3	3	2	2	4
TOTAL	8	57	40	30	20	5

Table 3: Sample of Chemistry Teachers Selected from Delta State

Senatorial Districts	LGA	Male	Female	Sample Selected		Total Sample Selected
		Chem Teachers	Chem Teachers	Male	Female	
Delta North	Aniocha North	12	3	3	1	4
	Aniocha South	8	11	3	4	7
	Ika North East	22	16	6	2	8
	Ika South	20	7	6	2	8
	Ndokwa East	8	6	3	2	5
	Ndokwa West	11	5	4	2	6
	Oshimili North	13	8	4	3	7
	Oshimili South	16	12	5	4	9
	Ukwani	13	7	4	2	6
	Ethiope East	19	8	5	3	8
	Ethiope West	8	14	2	4	6
	Sapele	21	15	5	5	10
Delta Central	Udu	6	23	2	8	10
	Okpe	12	12	4	4	8
	Ughelli North	41	33	12	10	22
	Ughelli South	12	11	5	5	10
	Uvwie	24	31	6	9	15

	Bomadi	3	1	2	1	3
	Burutu	4	0	2	0	2
	Isoko North	13	3	4	1	5
Delta South	Isoko South	8	8	3	3	6
	Patani	3	1	1	1	2
	Warri North	3	7	1	2	3
	Warri South	10	9	4	3	7
	Warri South West	1	2	1	1	2
Total		311	253	97	82	179

Research Instruments

The instrument comprises eight sections. Section A solicits demographic variables of the respondents regarding respondent's name of school, state and gender. The instruments for collection of qualitative data for the study comprised of classroom observation and lesson note checking. Classroom observation and lesson note checking was facilitated by using the classroom observation guides tagged Sections B and C. The classroom observation guides were also used for assessing chemistry teachers' content knowledge and pedagogical knowledge in answer to research questions 1 and 2. The B part contains eight items on content knowledge while the C part contained 12 items on pedagogical knowledge.

Section D of the instrument contained eight items titled "Content Knowledge for Chemistry Teachers Teaching Effectiveness Questionnaire" (CKCTTEQ). It is used to answer research question three as to whether any significant relationship exists between Chemistry teachers' content knowledge and their teaching effectiveness and test the corresponding hypothesis. Section E contains twelve items titled "Pedagogical Knowledge for Chemistry Teachers' Teaching Effectiveness Questionnaire"

(PKCTTEQ). It is used to answer research question four which focused on establishing the relationship that exists between Chemistry teachers' pedagogical knowledge and their teaching effectiveness and test the corresponding hypothesis.

The instrument for collection of other quantitative data consists of a structured questionnaire labelled (Sections F, G & H). Section F of the instrument contained 18 items used for the assessment of chemistry teachers' teaching effectiveness. It is titled "Chemistry Teachers Teaching Effectiveness Questionnaire" (CTTEQ). It is used to measure chemistry teachers teaching effectiveness in answer to research question five and the corresponding hypothesis. It was adapted from previous teachers teaching effectiveness instrument developed by Arubayi (2003; Polhmanm 1975), see section F of Appendix A. Sections G & H was adapted from of Aksu, Metin and Konyalioglu (2014) pedagogical content knowledge and Morrison & Luttenegger (2015) scale.

Section G contained 40 items which focused on chemistry teacher's pedagogical content knowledge for teaching the subject. It is titled "Chemistry Teachers' Pedagogical Content Knowledge Questionnaire" (CTPCKQ). It is used to answer research question 6 and the corresponding hypothesis. Section H contains fourteen items entitled "Strategies for Improving Chemistry Teachers Development of Pedagogical Content Knowledge Questionnaire"(SICTDPCKQ). It is meant for chemistry teachers aimed at identifying from their perspectives, the likely strategies for improving the development of pedagogical content knowledge for effective teaching of chemistry.

Validity of the Instrument

Only section B, C, D, E F and I of the questionnaires were given face and content validity by two experts in the Department of Science Education and Department of Educational Administration and Policy Studies Delta State University, Abraka. The content validity was carried out by the experts who read through each item and modified those they found not suitable. Five items that did not measure what they intended to measure were deleted. Based on their advice after thoroughly scrutinizing the instrument the correction they suggested were used to bear on the items before the final draft was produced. The sections F and G were not subjected to validation since they were adapted from Aksu, Metin and Konyalioglu (2014).

Reliability of the Instrument

The reliability of the instrument was only performed on the instruments which focused on finding out if any significant relationship existed between teachers' content knowledge, pedagogical knowledge and teaching effectiveness and the instrument which examined the strategies for enhanced development of chemistry teachers' pedagogical content knowledge. Cronbach alpha reliability technique was employed in doing this. This reliability technique is concerned with the internal consistency of the instrument. Using this method, the researcher administered the instrument once on 30 teachers in public secondary schools in Delta State not used in this study. The items were then subdivided into two halves on odd- and even- number basis. The scores of all the odd items were summed up as a group (X), while the scores of all the even items were summed up as another group (Y). The two groups of scores were correlated, using Pearson Product Moment formula. The reliability index obtained was stepped up using

Spearman Brown Prophecy Formula to obtain reliability indexes of 0.53, 0.71, 0.61 and 0.80. The results are attached as appendix A, B, C and D. Thus, this procedure helped to establish the internal consistency of the instrument and hence justify its use for the study.

Method of Data Collection

The qualitative data on the content and pedagogical knowledge chemistry teachers demonstrated during lesson in the classroom were collected using lesson note checking and classroom observation of teaching. The lesson note checking and classroom observation was conducted on 50 chemistry teachers in Bayelsa State and 179 chemistry teachers in Delta State. The researcher was assisted with the subject heads in each of the school during the checking of the lesson notes of the chemistry teachers. The quantitative data was collected by the use of structured questionnaire. The questionnaire was administered by the researcher, assisted by three research assistants, who were recruited from the sampled schools. The classroom observation guide was used to find out the information in answer to research questions 1 and 2. The researcher observed 50 chemistry teachers in Bayelsa State. For Delta State classroom observation was carried out on 179 chemistry teachers selected for the study. The questionnaire on strategies for enhanced development of pedagogical content knowledge of chemistry teachers were administered to the 229 chemistry teachers selected for the two states.

Method of Data Analysis

The research questions 1, 2, 5, 6 and 7 were answered using descriptive statistics such as mean and standard deviation; while research questions 3 and 4 were answered using Pearson coefficient of determination. Pearson Product Moment correlation statistics was used to test all the hypotheses 1, 2 and 6, which focused on ascertaining whether any

significant relationship existed between content knowledge and teaching effectiveness of chemistry teachers, pedagogical knowledge and teaching effectiveness of chemistry teachers and pedagogical content knowledge and teaching effectiveness of chemistry teachers respectively. Hypotheses 3, 4 and 5 were tested using t-test statistics. The level of significance was established at 0.05.

CHAPTER FOUR

PRESENTATION OF RESULTS AND DISCUSSION

This chapter focused on the presentation of the result of data analysis in answers to the research questions raised and testing the formulated hypotheses.

Research Questions

Research Question 1: What content knowledge do secondary school chemistry teachers in Bayelsa and Delta States demonstrate during lesson in the classroom?

Table 4: Analysis of the content knowledge demonstrated by secondary school chemistry teachers in Bayelsa and Delta States during lesson in the classroom

S/N	Items on content knowledge	Bayelsa State Chemistry Teachers N = 50			Delta State Chemistry Teachers N = 179			Total Score	Average Mean
		Score	Mean	SD	Score	Mean	SD		
1	Planning lesson in line with the topic to be taught or taught for each lesson	135	2.70	0.52	480	2.68	0.39	615	2.69
2	Knowledge of chemistry generally	134	2.69	0.56	609	3.40	0.47	743	3.05
3	Knowledge of simple laws underlying each topic in chemistry	163	3.25	0.34	514	2.87	0.55	677	3.06
4	Knowledge of the content for each topic to be taught	165	3.30	0.57	603	3.37	0.42	768	3.34
5	Application of chemistry principles underlying specific topic to be taught	132	2.63	0.46	496	2.77	0.31	628	2.70
6	Knowledge of chemical theories	143	2.86	0.79	612	3.42	0.57	755	3.14
7	Knowledge of chemistry concepts for specific topic	141	2.82	0.65	532	2.97	0.58	673	2.90
8	Knowledge of entry behaviour for each chemistry topic	184	3.67	0.39	678	3.79	0.65	862	3.73
9	Knowledge of instructional materials to be used when teaching specific topic in chemistry	165	3.29	0.67	533	2.98	0.68	698	3.14
	Total Mean		27.21			28.25		6419	27.75
	Average Mean		3.02			3.14			3.08

Table 5 is used to answer research question 1. It contains the result of data analysis based on content knowledge demonstrated by chemistry teachers during lesson in the classroom in Bayelsa and Delta States. The mean score of 2.50 was used as the mid-point and cut off point for arriving at decision. Items having mean score from 2.50 and above were accepted while items having mean score from 2.49 and below were not accepted.

For Bayelsa State, the average mean score of 3.02 is above the cut-off mean score of 2.50. Therefore Bayelsa State public secondary school chemistry teachers demonstrate good content knowledge during lesson in the classroom. For Delta State, the average mean score of 3.14 is above the cut-off mean score of 2.50. Therefore Delta State public secondary school chemistry teachers demonstrate good content knowledge during lesson in the classroom. In addition, the overall mean score of 3.08 implies that chemistry teachers in the two states demonstrated good content knowledge during lesson in the classroom, although Delta State chemistry teachers appears to demonstrate more content knowledge than their Bayelsa State counterparts.

Research Question 2: What pedagogical knowledge do secondary schools chemistry teachers in Bayelsa and Delta States demonstrate during lesson in the classroom?

Table 5: Analysis of the pedagogical knowledge demonstrated by secondary school chemistry teachers in Bayelsa and Delta States during lesson in the classroom

S/N	Items on pedagogical knowledge	Bayelsa State Chemistry Teachers N = 50			Delta State Chemistry Teachers N = 179		
		Score	Mean	SD	Score	Mean	SD
1	Clarity of behavioural objective	168	3.35	0.75	630	3.52	0.34
2	Ability to start each specific lesson with good method	160	3.20	0.32	583	3.26	0.64
3	Ability to relate topic with student s' level	145	2.90	0.47	590	3.30	0.59
4	Ability to motivate students for their responses	107	2.13	0.31	433	2.42	0.45
5	Teacher's use of appropriate teaching aids to enhance students' understanding	129	2.57	0.45	468	2.62	0.48
6	Teacher's questioning approaches	137	2.73	0.43	479	2.68	0.57
7	Knowledge of when to involve students in their learning	144	2.88	0.38	537	3.00	0.69
8	Teacher's knowledge of teaching methods appropriate for each topic	123	2.46	0.37	490	2.74	0.42
9	Ability to make judicious use of variety of teaching methods for different topics	134	2.67	0.48	486	2.72	0.68
10	Teaching from simple terms to complex terms and from known to unknown	143	2.86	0.38	490	2.74	0.79
11	Knowledge of how to evaluate students' learning	133	2.65	0.47	485	2.71	0.69
12	Knowledge of an understanding of how students' learn	148	2.95	0.62	533	2.98	0.48
	Total	1671	33.35	5.43	6204	34.69	6.82
	Average Mean		2.78			2.89	

Table 5 is used to answer research question 2. It contains the result of data analysis based on pedagogical knowledge demonstrated by chemistry teachers during lesson in the classroom in Bayelsa and Delta States. The mean score of 2.50 was used as the mid-point and cut off point for arriving at decision. Items having mean score from 2.50 and above were accepted while items having mean score from 2.49 and below were not accepted.

The data in Table 5 shows that for Bayelsa State chemistry teachers, the average mean score is 2.78. It can be said that chemistry teachers in Bayelsa State demonstrated good knowledge of pedagogy during lesson in the classroom. But for Delta State chemistry teachers, the average mean score is 2.89. It can also be said that chemistry

teachers in Delta State demonstrated good content knowledge during lesson in the classroom.

The overall average mean score of 2.84 is indicative that chemistry teachers in the two states demonstrated good pedagogical knowledge in the during lesson classroom. However, chemistry teachers in the two states do not demonstrate pedagogical knowledge in terms of ability to motivate students for their responses. Bayelsa State chemistry teachers do not demonstrate pedagogical knowledge of teaching methods appropriate for each topic.

Research Question 3: What is the relationship between content knowledge and teaching effectiveness of chemistry teachers in Bayelsa and Delta States secondary schools?

Table 6: Summary of Descriptive statistics and correlation between content knowledge and teaching effectiveness of chemistry teachers in Bayelsa and Delta States secondary schools

States	Variables	N	Mean	SD	R	r ²	Decision
	Content Knowledge	50	2.86	0.48			
Bayelsa State	Teaching Effectiveness	50	3.25	0.42	0.38	0.14	Medium Positive Correlation
	Content Knowledge	179	2.96	0.48			
Delta State	Teaching Effectiveness	179	3.15	0.41	0.22	0.05	Small Positive Correlation

Table 6 shows the relationship between content knowledge and teaching effectiveness of chemistry teachers in Bayelsa and Delta States Secondary schools. Cohen (1988) suggested that for determining the strength of relationship, $r = .10$ to $.29$ is small but $r = .30$ to $.49$ is medium. But $r = .50$ to 1.0 = large. Therefore for Bayelsa State, since calculated $r = .38$, it means medium relationship between chemistry teachers content knowledge and teaching effectiveness. For Delta State, the calculated $r = .22$ implies small positive relationship.

Research Question 4: What is the relationship between pedagogical knowledge and teaching effectiveness of chemistry teachers in Bayelsa and Delta States secondary schools?

Table 7: Summary of Descriptive statistics and correlation between pedagogical knowledge and teaching effectiveness of chemistry teachers in Bayelsa and Delta States secondary schools

States	Variables	N	Mean	SD	R	r ²	Decision
	Pedagogical Knowledge	50	3.03	0.45			
Bayelsa State	Teaching Effectiveness	50	3.25	0.42	0.14	0.02	Small Positive Correlation
	Pedagogical Knowledge	179	2.65	0.57			
Delta State	Teaching Effectiveness	179	3.15	0.41	0.23	0.05	Small Positive Correlation

Table 7 shows the relationship between pedagogical knowledge and teaching effectiveness of chemistry teachers in Bayelsa and Delta States secondary schools. Following Cohen (1988) suggested formula for determining the strength of relationship, $r = .10$ to $.29$ is small but $r = .30$ to $.49$ is medium. But $r = .50$ to 1.0 = large. Therefore, for Bayelsa State, since calculated $r = 0.14$, it means small positive relationship between chemistry teachers pedagogical knowledge and teaching effectiveness. For Delta State, the calculated $r = 0.23$ implies small positive relationship between chemistry teachers pedagogical knowledge and teaching effectiveness.

Research Question 5: What is the extent of teaching effectiveness of chemistry teachers in Bayelsa and Delta States public secondary schools?

Table 8: Mean ratings of chemistry teachers in Bayelsa and Delta States public secondary schools teaching effectiveness

S/N	Items on chemistry Teachers Teaching Effectiveness	Bayelsa State			Delta State		
		Score	Mean	SD	Score	Mean	SD
1	Careful planning of each lesson period	176	3.52	0.60	627	3.50	0.51
2	Ability to communicate effectively with students during lesson	175	3.50	0.71	607	3.39	0.75
3	Regular attendance at class	167	3.33	0.73	594	3.32	1.10
4	Listening to students' opinions	160	3.19	0.95	609	3.40	0.75
5	Provision of relevant feedback to students	169	3.37	0.70	596	3.33	0.91
6	Use of relevant instructional materials for topics taught	113	2.26	0.86	390	2.18	0.64
7	Gets students actively engaged during instruction	165	3.30	0.69	609	3.40	0.78
8	Gives assignment that is relevant to topics taught	162	3.23	0.80	573	3.20	0.83
9	Exhibits care and respect for students	160	3.19	0.77	582	3.25	0.83
10	Clearly makes the objectives of lesson known to students	164	3.28	0.79	573	3.20	0.65
11	Ability to apply variety of instructional strategies during lesson	159	3.18	0.78	554	3.10	0.68
12	Ability to effectively manage the classroom	164	3.28	0.85	537	3.00	0.85
13	Motivates students in their learning	161	3.21	0.80	582	3.25	0.79
14	Ability to cover the curricula content outlined for each topic	156	3.12	0.76	573	3.20	0.74
15	Ability to differentiate learning for individual students	111	2.21	0.72	412	2.30	0.82
16	Socializes with students	157	3.14	0.81	569	3.18	0.75
17	Demonstrates enthusiasm for students	156	3.12	0.77	573	3.20	0.83
18	Demonstrates enthusiasm for subject matter	160	3.19	0.77	619	3.46	0.69
	Total	2835	56.52	13.08	10179	57.04	13.07
	Average Mean		3.14			3.17	

Table 8 is used to answer research question 5. It contains the result of data analysis based on rating of teaching effectiveness of chemistry teachers in Bayelsa and Delta States public secondary schools. The mean score of 2.50 was used as the mid-point and cut off point for arriving at decision. Any Item having mean score from 2.50 and above is accepted to mean chemistry teacher are effective in teaching while items having mean score from 2.49 and below were not accepted. This implies that chemistry teachers are not effective in teaching.

Table 8 indicates that the average mean score for Bayelsa State is 3.14. This mean score is above 2.50 the cut-off. Therefore Bayelsa State chemistry teachers can be said to teach chemistry effectively. The average mean score for Delta State chemistry teachers is 3.17. It can thus be inferred that chemistry teachers in Delta State teach the subject effectively. The overall mean score for the two states is 3.15. This implies that the teaching effectiveness of chemistry teachers in Bayelsa and Delta states public secondary schools is good.

From the Table, only two items (6) and (15) recorded mean score below 2.50 for both States. That is use of relevant instruction materials for topic being taught with mean score of 2.26 for Bayelsa State and 2.18 for Delta State and ability to differentiate learning for individual student with mean score of 2.21 for Bayelsa State and 2.12 for Delta State. This implication of this is that chemistry teachers in the Bayelsa State are not effective in areas such as use of relevant instruction materials for topic being taught and ability to differentiate learning for individual student for chemistry teachers in the two states.

Research Question 6: What pedagogical content knowledge do male and female chemistry teachers of public secondary schools in Bayelsa and Delta States possess for effective teaching of the subject?

Table 9: Mean score analysis of pedagogical content knowledge of chemistry teachers in Bayelsa and Delta States public secondary school

S/N	Pedagogical Content Knowledge of Chemistry Teachers	Bayelsa						Delta					
		Male			Female			Male			Female		
		Score	Mean	SD	score	Mean	SD	score	Mean	SD	score	Mean	SD
1	Ability to break down tasks when teaching for student easy understanding	94	3.28	0.71	67	3.34	0.67	299	3.09	0.68	254	3.10	0.74
2	knowledge of curricula materials for topics in chemistry	97	3.23	0.74	70	3.52	2.66	316	3.26	0.66	262	3.20	0.75
3	Ability to use appropriate technical terms in chemistry when teaching	65	2.18	0.47	43	2.16	0.46	241	2.48	0.66	201	2.46	0.75
4	Use of multiple representations during chemistry lesson	70	2.32	0.65	45	2.23	0.57	257	2.65	0.70	212	2.59	0.74
5	knowledge of chemical principles and laws	75	2.50	0.72	48	2.39	0.67	252	2.60	0.77	224	2.74	0.70
6	Ability to organize instruction to boost students' learning	64	2.13	0.41	45	2.25	0.57	226	2.33	0.62	199	2.43	0.71
7	Ability to relate chemistry topics to natural occurrences when teaching	67	2.24	0.56	45	2.25	0.60	250	2.58	0.81	213	2.60	0.77
8	knowledge of application of teaching skills to boost students learning of chemistry	89	2.98	0.75	61	3.07	0.77	279	2.88	0.80	252	3.07	0.81
9	Knowledge of how to teach both physical and practical chemistry	80	2.68	0.72	56	2.78	0.77	283	2.92	0.77	234	2.85	0.83
10	Giving life examples when teaching chemistry	87	2.90	0.66	61	3.04	0.79	268	2.76	0.78	238	2.91	0.75
11	Use of variety of teaching methods during instruction	93	3.11	0.72	64	3.22	0.75	304	3.13	0.76	256	3.12	0.75
12	Ability to recognize slow learners during instruction	65	2.15	0.50	43	2.13	0.47	252	2.64	0.78	213	2.60	0.79
13	Ability to manage the classroom effectively when teaching	63	2.10	0.34	42	2.09	0.36	281	2.90	0.81	213	2.60	0.79
14	Knowledge of how to reward and motivates students during instruction	68	2.28	0.61	44	2.22	0.53	258	2.66	0.72	227	2.78	0.73
15	Knowledge of use of practical examples to manage students' behaviour	72	2.40	0.68	45	2.24	0.51	254	2.62	0.78	218	2.66	0.82
16	Knowledge of students' misconceptions during lesson	63	2.11	0.42	43	2.17	0.50	233	2.40	0.69	215	2.63	0.78
17	Knowledge of students' conceptions during chemistry lesson	65	2.17	0.49	44	2.19	0.51	262	2.70	0.69	220	2.69	0.84
18	Knowledge of use of different innovative strategies to teach chemistry	83	2.78	0.89	58	2.89	0.85	291	3.00	0.75	246	3.00	0.78
19	Knowledge of presentation of topics from concrete to abstract	69	2.31	0.62	47	2.33	0.61	275	2.84	0.76	212	2.58	0.70
20	Knowledge of the use of different questioning techniques during instruction	62	2.07	0.38	43	2.13	0.46	247	2.55	0.74	200	2.44	0.73
21	Knowledge of presentation of chemistry topics from simple to complex and from known to	95	3.18	0.77	67	3.34	0.80	297	3.06	0.64	262	3.19	0.66

	unknown												
22	Knowledge of students' understanding of concepts taught	96	3.21	0.72	63	3.16	0.81	304	3.14	0.63	251	3.06	0.72
23	Knowledge of how to cater for all categories of students	90	3.00	0.90	66	3.28	0.80	281	2.90	0.87	262	3.20	0.82
24	Ability to create positive classroom psychosocial learning environment	94	3.12	0.85	65	3.27	0.77	285	2.94	0.79	267	3.26	0.86
25	Knowledge of formation evaluation technique during chemistry lesson	90	3.01	0.79	64	3.18	0.73	292	3.02	0.76	256	3.12	0.81
26	Knowledge of use of relevant teaching aids during chemistry lesson	92	3.07	0.75	66	3.30	0.69	281	2.90	0.71	243	2.96	0.78
27	Ability to allow students to reflect on what we have learnt during lesson	88	2.99	0.82	65	3.23	0.79	289	2.98	0.74	250	3.05	0.89
28	Knowledge of summative evaluation technique during chemistry lesson	92	3.06	0.74	63	3.16	0.78	299	3.09	0.71	256	3.12	0.80
29	Ability to provide feedback to students during chemistry lesson	95	3.16	0.76	64	3.22	0.77	311	3.21	0.73	89	3.54	0.64
30	Ability to provide timely feedback to students during lesson	95	3.18	0.77	67	3.34	0.80	291	3.00	0.64	89	3.19	0.66
31	Knowledge of how to creates a democratic classroom environment that allows students to express themselves freely	96	3.21	0.72	63	3.16	0.81	311	3.21	0.63	251	3.06	0.72
32	Ability to control emotions during lesson	90	3.00	0.90	66	3.28	0.80	286	2.95	0.87	262	3.20	0.82
33	Knowledge of uses of several approaches to engage and stimulate students' curiosity in learning chemistry	94	3.12	0.85	65	3.27	0.77	285	2.94	0.79	258	3.15	0.86
34	Understanding students' misconception during lesson	90	3.01	0.79	64	3.18	0.73	295	3.06	0.76	264	3.22	0.81
35	Teacher giving of relevant examples when teaching chemistry	92	3.07	0.75	66	3.30	0.69	289	2.98	0.71	243	2.96	0.78
36	Ability to recognize students' prior knowledge during lesson	90	2.99	0.82	65	3.23	0.79	289	2.98	0.74	250	3.05	0.89
37	Ability to considers students' individual difference during lesson	92	3.06	0.74	63	3.16	0.78	329	3.40	0.71	266	3.24	0.80
38	Knowledge of how to assess students' performance during lesson	95	3.16	0.76	64	3.22	0.77	323	3.33	0.73	290	3.54	0.64
39	Knowledge of how to handle negative situations in the classroom	90	2.99	0.82	65	3.23	0.79	279	2.88	0.74	282	3.45	0.89
40	Ability to use assessment tools suitable for teaching topics in chemistry	134	3.06	0.74	63	3.16	0.78	297	3.06	0.71	256	3.12	0.80

Table 9 is used to answer research question 6. It contains the result of data analysis based on the rating of male and female chemistry teachers in Bayelsa and Delta States pedagogical content knowledge for teaching the subject.

For Bayelsa State, the mean score for each of the item except items 3 (teacher uses appropriate technical chemistry terms when teaching) for both categories of teachers in the two states, item 6 knowledge of application of chemical laws and principles where necessary when teaching chemistry) and 12 (chemistry teacher recognizes slow learners during lesson) for Bayelsa state male and female chemistry teachers with mean scores of 2.11 & 2.45 Bayelsa State, and 37 (2.25 & 2.31 for Bayelsa State, teacher considers individual differences among learners during lesson 2.30 for female students Delta State) is above 2.50 the cut-off score. Hence chemistry teachers in Bayelsa State and Delta states could be said to have good pedagogical content knowledge for effective teaching of the subject.

Research Question 7: What strategies can be employed for enhanced development of chemistry teachers' pedagogical content knowledge for teaching the subject in Bayelsa and Delta States secondary schools?

Table 10: Mean ratings on chemistry teachers in Bayelsa and Delta States on strategies for enhanced development of pedagogical content knowledge

S/N	Items on strategies for enhanced development of pedagogical content knowledge	Bayelsa Chemistry Teachers N = 50			Delta Chemistry Teachers N = 179		
		Score	Mean	SD	Score	Mean	SD
1	Intensive in-service training for less experienced chemistry teachers on a regular basis	187	3.74	0.88	537	3.00	0.88
2	In-built training workshops in chemistry within schools on a termly basis	172	3.43	0.73	573	3.20	0.54
3	Building in professional development programmes in selected chemistry topics into school activities	161	3.22	1.11	533	2.98	0.43
4	Linking teacher's professional development to students learning	144	2.88	0.90	489	2.73	0.56
5	Mentoring of less experience chemistry teachers by head teachers	181	3.62	0.55	627	3.50	0.34
6	STAN focusing conferences for chemistry teachers on difficult topics	117	2.33	0.42	410	2.29	0.59
7	Provision of current chemistry journals in school libraries	138	2.75	0.56	471	2.63	0.66

8	Publishers of chemistry textbooks should concentrate on difficult topics in the subject	123	2.45	0.62	369	2.06	0.55
9	Provision of current chemistry textbooks in school libraries	143	2.85	0.50	476	2.66	0.82
10	Regular classroom practice	170	3.40	0.46	644	3.60	0.65
11	Provision of visual games materials to enhance the teaching of chemistry	111	2.22	0.58	379	2.12	0.59
12	Empowering chemistry teachers through formal workshop attendance in other countries	177	3.54	0.69	609	3.40	0.70
13	Private involvement in organizing chemistry education programmes	105	2.10	0.72	394	2.20	0.62
14	Sponsoring chemistry teachers on field trip to watch other schools to watch experts teach difficult topics in the subject	132	2.64	0.98	490	2.74	0.77
	Total	2061	39.77	9.50	7001	39.44	8.68
	Average Mean		2.84			2.82	

Table 10 contain the result of data analysis in answer to research question 7 which focused on the \$strategies for enhanced development of chemistry teachers' pedagogical content knowledge for teaching the subject in secondary schools in Bayelsa and Delta States. For Bayelsa State, the average mean score is 2.84 and for Delta State, it is 2.82. Principals and teachers in the two States have similar views on the strategies for enhanced development of pedagogical content knowledge of chemistry teachers in the states. The overall mean score of 2.79 further suggests that the respondents in Bayelsa and Delta States have similar views on the identified strategies for enhanced development of pedagogical content knowledge of chemistry teachers.

For Bayelsa state the identified strategies are intensive in-service training for less experienced chemistry teachers, in-built training workshops for chemistry teachers, integrating professional development programmes in school activities, mentoring less experienced chemistry teachers, mentoring less experienced chemistry teachers, sponsoring chemistry teachers on field trip to other schools and empowering them through summer workshop attendance.

For Delta state the identified strategies for enhanced development of chemistry teachers pedagogical content knowledge are in-built training workshops for chemistry teachers, integrating professional development programmes in school activities, mentoring less experienced chemistry teachers, sponsoring chemistry teachers on field trip to other schools, provision of current chemistry textbooks in school library, regular classroom practice and empowering chemistry teacher through workshop attendance in other countries.

The respondents in the two states did not agree that involving private sector in organising conferences for chemistry teachers and concentrating publication of chemistry textbooks on difficult topics as well as provision of visual games materials to facilitate the teaching of chemistry are strategies for improving the enhanced development of chemistry teachers' pedagogical content knowledge.

Research Question 8: What is the relationship between pedagogical content knowledge and teaching effectiveness among secondary school chemistry teachers in Bayelsa and Delta State?

Table 11: Summary of Descriptive statistics and correlation pedagogical content knowledge and teaching effectiveness among secondary school chemistry teachers in Bayelsa and Delta State

States	Variables	N	Mean	SD	R	r ²	Decision
	Pedagogical Content Knowledge	50	2.85	0.28			
Bayelsa State	Teaching Effectiveness	50	3.25	0.42	0.81	0.02	Large Positive Correlation
	Pedagogical Content Knowledge	179	2.91	0.28			
Delta State	Teaching Effectiveness	179	3.25	0.41	0.74	0.05	Large Positive Correlation

Table 12 shows the correlation between pedagogical content knowledge and teaching effectiveness among secondary school chemistry teachers in Bayelsa and Delta State. For Bayelsa State, the calculated r value is 0.81 but for Delta State the calculated r value is 0.74. The r values for the two states suggest high positive correlation between pedagogical content knowledge and teaching effectiveness of chemistry teachers in the two states.

Hypotheses Testing

Hypothesis 1: There is no significant relationship between content knowledge and teaching effectiveness of chemistry teachers among public secondary schools in Bayelsa and Delta States.

The result of data analysis for testing hypothesis 1 which was formulated from research question 3 is presented in Table 12

Table 12: Analysis of the relationship between content knowledge and teaching effectiveness of chemistry teachers among public secondary schools in Bayelsa and Delta States

	Variable	N	Mean	SD	r	P-Value	Decision
Bayelsa State	Content Knowledge	50	3.02	0.55	0.38	0.000	Significant
	Teaching Effectiveness	50	3.25	0.42			
Delta State	Content Knowledge	179	3.14	0.51	0.20	0.001	Significant
	Teaching Effectiveness	179	3.25	0.41			

From Table 12 the r value for Bayelsa State is 0.38 at 0.05 significant level. The r value of 0.38 is significant at 0.05 level. This means that there is a significant relationship between content knowledge and teaching effectiveness among chemistry teachers in Bayelsa State. For Delta State, the calculated r value of 0.20 is significant at 0.05

significant level. This indicates a significant relationship between content knowledge and teaching effectiveness among chemistry teachers in Delta State. To find the difference between the two correlation coefficients (content knowledge and teaching effectiveness in the two states, Fisher's z statistics was applied and z value of 1.07 was obtained, p one tailed = 0.1423, two tailed = 0.2846. Since z value is positive, it indicates a positive relationship between content knowledge and teaching effectiveness in the two states.

Hypothesis 2: There is no significant relationship between pedagogical knowledge and teaching effectiveness of chemistry teachers among public secondary schools in Bayelsa and Delta States.

The result of data analysis for testing hypothesis 2 which was formulated to correspond with research question 4 is presented in Table 13

Table 13: Summary of Analysis of the relationship between pedagogical knowledge and teaching effectiveness of chemistry teachers among public secondary schools in Bayelsa and Delta States

	Variable	N	Mean	SD	r	P-Value	Decision
Bayelsa State	Pedagogical Knowledge	50	2.78	0.45	0.18	0.04	Significant
	Teaching Effectiveness	50	3.25	0.42			
Delta State	Pedagogical Knowledge	179	2.86	0.57	0.26	0.000	Significant
	Teaching Effectiveness	179	3.25	0.41			

From the data in Table 13, for Bayelsa State, the r calculated value is 0.18 at 0.05 alpha level. This implies that a significant relationship existed between chemistry teachers' pedagogical content knowledge and teaching effectiveness. For Delta State, the calculated r value is 0.26. This means that there is a significant relationship between chemistry teachers' pedagogical content knowledge and teaching effectiveness.

Comparing the two States, the relationship between pedagogical content knowledge and teaching effectiveness is more positive for chemistry teachers in Delta State ($r = 0.23$) secondary schools than their counterpart in Bayelsa State ($r = 0.14$). Fisher z statistics is applied to find the significance of the difference between the two correlation coefficients the two states. Z value of -0.51 was obtained, p one tailed = 0.3050, two tailed = 0.6101. Since z value is negative, it indicates a negative relationship between pedagogical knowledge and teaching effectiveness in the two states.

Hypothesis 3: There is no significant difference between the teaching effectiveness of chemistry teachers in Bayelsa and Delta States public secondary schools.

Table 14: Summary of t test Analysis of the difference between the mean perception scores of chemistry teachers teaching effectiveness in Bayelsa and Delta States public secondary schools

State	N	Mean	SD	t-Cal	P	Decision
Bayelsa	50	3.25	0.42	2.632	0.001	Significant
Delta	179	3.15	0.41	2.561		

From Table 14, for Bayelsa State and Delta State, the t-calculated values of 2.632 and 2.561 respectively, at df 227, t table value of 2.033 are significant at 0.05 alpha level. This is because the calculated t values are greater than the table t value. The hypothesis 3 is therefore accepted. This means that there is a significant difference between the mean scores of male and female chemistry teachers teaching effectiveness.

Hypothesis 4: There is no significant difference between the mean scores of male and female chemistry teachers in Bayelsa and Delta States with respect to their pedagogical content knowledge for teaching chemistry.

Table 15: Summary of t test Analysis of the difference between the mean scores of male and female chemistry teachers in Bayelsa and Delta States public secondary schools regarding their PCK for teaching the subject

Variable		N	Mean	SD	t-cal	p	Decision
Bayelsa State	Male	30	2.79	0.29	2.38	0.00	Significant
	Female	20	2.88	0.27			
Delta State	Male	97	2.88	0.26	1.90	0.00	Not Significant
	Female	82	2.95	0.30			

From Table 15, for Bayelsa State, the t-calculated value of 2.38 is significant at 0.05 alpha level, df 227 and critical t value of 1.96. Hypothesis 4 is not accepted for Bayelsa state. This means that there is a significant difference between the PCK male and female chemistry teachers in Bayelsa state for teaching the subject. But for Delta State, the t-calculated value of 1.90 is less than the critical t value of 1.96 at 0.05 alpha level, df 227 is not significant. Hence, the null hypothesis is retained. This means that there is no significant difference between the PCK of male and female chemistry teachers in Delta state for teaching the subject.

Hypothesis 5: The strategies for enhanced development of pedagogical content knowledge of chemistry teachers will not significantly differ among public secondary schools in Bayelsa and Delta States.

Table 16: Summary of Analysis of on the strategies that could be adopted for enhanced development of PCK for teaching chemistry

Status	N	Mean	SD	t-Cal	P	Decision
Delta	179	39.70	9.35	2.102	0.002	Not Significant
Bayelsa	50	39.44	8.61	2.031		

From table 16, for Delta States, the t-calculated value of 2.102 is not significant at 0.05 alpha level, $df = 227$. For Bayelsa State, the t calculated value is 2.031 at $df = 227$ and 0.05 confidence level. The calculated value is not significant at 0.05 alpha level for Bayelsa State and Delta State. Therefore the null hypothesis is accepted. This means that the strategies for enhanced development of chemistry teachers' pedagogical content knowledge among public secondary schools in Bayelsa and Delta States did not differ significantly.

Hypothesis 6: There is no significant relationship between pedagogical content knowledge and teaching effectiveness of chemistry teachers among public secondary schools in Bayelsa and Delta States.

The result of data analysis for testing hypothesis 6 which focused on the relationship between pedagogical content knowledge and teaching effectiveness of chemistry teachers is presented in Table 17.

Table 17: Summary of Analysis of the relationship between pedagogical content knowledge and teaching effectiveness of chemistry teachers among public secondary schools in Bayelsa and Delta States

	Variable	N	Mean	SD	r	P-Value	Decision
Bayelsa State	Pedagogical Content Knowledge	50	2.88	0.38	0.84	0.00	Significant
	Teaching Effectiveness	50	3.21	0.47			
Delta State	Pedagogical Content Knowledge	179	2.93	0.52	0.77	0.00	Significant
	Teaching Effectiveness	179	3.21	0.44			

From the data in Table 17, for Bayelsa State, the r calculated value is 0.84 at 0.05 alpha level. This implies that a positive significant relationship existed between chemistry teachers' pedagogical content knowledge and teaching effectiveness. For Delta State, the calculated r value is 0.77. To compute the significance of difference between the two correlations, Fisher's z statistics was applied and z value of 1.22, one tailed = 0.1112, two Tailed = 0.2225 were obtained. This positive z value means that there is a significant relationship between chemistry teachers' pedagogical content knowledge and teaching effectiveness.

Discussion of the Findings

The discussion is in respect of lesson observation, the research questions answered and the hypotheses tested. The result from lesson observation by the researcher revealed that for Bayelsa State and Delta State secondary school chemistry teachers has adequate content knowledge. However, chemistry teachers in Delta State appears to be more regular in writing daily lesson notes, exhibited good general knowledge of chemistry and have more adequate knowledge of entry behaviour for each topic. While Bayelsa State secondary school chemistry teachers appears to have more adequate knowledge of chemistry concepts and knowledge of instructional material to be used for teaching specifics topics in chemistry. In terms of classroom lesson observation based on knowledge of pedagogy, secondary school chemistry teachers in Bayelsa and Delta State have adequate pedagogical knowledge. The behavioural objectives of each lesson observed were clearly written using action verbs in unambiguous terms. Lessons were well started with good methods and taught by relating it to student's level. Some of the teachers were able to interchange the methods of teaching in order to make the lesson

interesting and comprehensive to students. Students were asked some questions during lesson. Nevertheless, Delta State secondary school chemistry teachers seems to show better pedagogical knowledge in areas such as making judicious use of questions to elicit students' understanding, the use of humour to make topics interesting and sustain students' attention, involve students by calling them to demonstrate by writing on the white board and motivate students who answered questions during lesson. Although chemistry teachers in Bayelsa State exhibited better knowledge of evaluation of student's learning and was more down to earth in terms of assisting students who had difficulty in drawing some structures and writing some chemical representations on the white board.

The result obtained for the first research question as indicated by the overall mean score revealed that chemistry teachers in Bayelsa and Delta State demonstrated a good content knowledge which enhanced their teaching effectiveness in the classroom during lesson. However, the slightly higher mean score for Delta State chemistry teachers appear to imply that they demonstrated more content knowledge during the teaching of the subject in the classroom than chemistry teachers in Bayelsa State. The hypothesis tested showed that there was a significant relationship between content knowledge and teaching effectiveness of chemistry teachers in the two States. Similar finding by Capraro, Capraro, Parker, et al. (2005) in Mathematics and Jong, Van and Varloop (2005) in Chemistry revealed that teachers' content knowledge has positive relationship with their teaching effectiveness. In addition, Krauss, Baumert & Blum (2008) study conducted in Germany using mathematics teachers proved that mathematics and science teachers need a high level of common content knowledge, specialized content knowledge and pedagogical content knowledge for quality instruction. In Chemistry, Jong, Van Driel, &

Verloop (2005) revealed that pre-service teachers' content knowledge has positive relationship with teachers' teaching effectiveness.

For the second research question, findings revealed that chemistry teachers in Bayelsa and Delta States demonstrated good pedagogical knowledge during lesson in the classroom. This helped in improving their teaching effectiveness in the classroom during lesson. The hypothesis tested showed that there was a significant relationship between pedagogical knowledge and teaching effectiveness of chemistry teachers in the two States. This finding lends credence with Aksu, et al (2014), that teachers need deep pedagogical knowledge in order to understand how students construct knowledge and teach effectively. In addition, Jones & Moreland (2005) noted that teachers need sufficient pedagogical knowledge to respond to students productively. The finding also lends credence with Auseon (1995) that a teacher's instruction is affected by his/her pedagogical knowledge in terms of lesson planning, lesson delivery and evaluation, knowledge of learners and learning and curricula knowledge. Thus, it is clear that for chemistry teachers to conduct meaningful classroom activities for students' purposeful learning, they must possess adequate pedagogical knowledge.

For the third research question the finding of the study revealed that for Bayelsa State, there is a medium positive relationship between content knowledge and teaching effectiveness of chemistry teachers. For Delta State there is a small positive relationship between content knowledge and teaching effectiveness of chemistry teachers. Hence there is a significant relationship between content knowledge and teaching effectiveness of chemistry teachers in Bayelsa and Delta States. For research question four, the findings revealed that there for Bayelsa State, there is a small positive correlation

between pedagogical knowledge and teaching effectiveness of chemistry teachers. For Delta State there is a small positive correlation between pedagogical knowledge and teaching effectiveness of chemistry teachers. Hence there is a significant relationship between pedagogical knowledge and teaching effectiveness of chemistry teachers in Bayelsa and Delta States.

The finding for research question 5 showed that chemistry teachers teaching effectiveness was high in many aspects. For Bayelsa and Delta States, chemistry students said their teachers planned each lesson carefully, they communicated effectively with them during lesson, they said their teachers were regular at class attendance and listened to students' opinions. The chemistry teachers in the two States positively actively engaged their students during lesson, they gave assignments that were relevant to topics taught, they showed care and respect for students, they used a variety of instructional strategies and made the objectives of the lesson known to students. In addition, the chemistry students expressed that their teachers were able to manage the classroom during lesson and motivated them in their learning. And that their teachers demonstrated enthusiasm for subject matter and for them and socialize with them. However, the chemistry students rated their teachers poorly in areas such as use of relevant instructional materials for topics taught and ability to differentiate learning for individual students. The findings lend credence with earlier findings of Rivkin, Hanushek & Kain (2005), Watson & De Geest (2005) and Odden, Borman & Permanich (2004). They expressed that effective teachers have high expectations for students, they contribute to positive academic, social and attitudinal outcomes of students, use diverse resources to

plan, structure lesson and engaged students in learning opportunities as well as monitor students' progress formatively and exhibits enthusiasm for subject matter.

For research question 6, the findings revealed that male and female chemistry teachers in the two states possess good pedagogical content knowledge. The hypothesis tested revealed that for Bayelsa State, the null hypothesis is not accepted thus implying that there is a significant difference between the mean perception scores of male and female chemistry teachers regarding their pedagogical content knowledge for teaching the subject. But for Delta State, the null hypothesis is retained, thus implying that there is no significant difference between the mean perception scores of male and female chemistry teachers regarding their teachers' pedagogical content knowledge for teaching the subject. The probable reason for this variation could be the location of the schools and chemistry teachers' characteristics.

For research question 7, the findings revealed that there are several strategies that could be adopted for enhanced development of chemistry teachers' pedagogical content knowledge. These strategies are intensive in-service training programmes for less experienced chemistry teachers, schools building in professional development programmes into their activities per term, empowering chemistry teachers by sponsoring them to workshops during summer period, provision of current chemistry Journals and textbooks in school library, mentoring of less experienced chemistry teachers and sending chemistry teachers on field trip to other schools to watch expert teachers teaching. Through these identified strategies chemistry teachers in Bayelsa and Delta states capacity building can be enhanced for adequate knowledge updating in content, pedagogy and pedagogical content knowledge for improved teaching of the subject and students'

better learning. The hypothesis tested revealed that there is no significant difference between the mean perception scores of chemistry teachers and principals in Bayelsa and Delta States with respect to the strategies that could be adopted for enhanced development of pedagogical content knowledge (PCK) for teaching chemistry.

Supporting these findings, Darling-Hammond, Chung Wei, Andree, Richardson & Orphanos (2009) revealed that intensive and sustained professional development programme over an extended period of time is the most effective collaborative learning for empowering teachers' knowledge base for effective teaching. Also this finding agrees with Lin-Teo, Chuo & Cheang (2007) that teachers training through seminars, workshops and professional development were potential sources through which they acquire and develop pedagogical content knowledge for good teaching. The finding of this study on mentoring as a strategy for enhanced development of chemistry teachers' pedagogical content knowledge has the supports of Hafner, Meffatt and Kisa (2011) and Terrion and Leonard (2011) that mentoring enhances teachers' instructional practices, professional growth, academic development and the development of social skills.

For research question 8, the finding revealed that in Bayelsa and Delta States, there was high positive correlation between pedagogical content knowledge and teaching effectiveness of chemistry teachers. This implies that there is a great association between a teacher's pedagogical content knowledge and his/her teaching effectiveness. This finding is in agreement with Park & Oliver, (2008) and Olunipekun & Aina (2014). They described pedagogical content knowledge as a specific and unique body of knowledge needed by teachers for successful conduct of teaching in complex and varied contexts. Additionally, Rollnick, Bennett, Rhemtula, Dharsey & Ndlovu (2008) established that in

the teaching process, pedagogical content knowledge is needed by teachers in order to provide effective teaching and promote learners' understanding of the lesson. Hence, without adequate pedagogical content knowledge, a teacher would not be able to teach effectively. Several qualitative studies have also shown that teachers' education and professional development are sources for the development of content knowledge and pedagogical content knowledge (Cochran-Smith & Zeichner, 2005; Darling-Hammond, Wei, Andree et al., 2009; Kleickmann, Richter, Kunter, Elsner, Bessner, Krauss, & Baumert, 2013). Werquin (2010) found that teacher development of content and pedagogical content knowledge was from formal and informal learning opportunities.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter summarizes the entire study. It attempted to outline the research findings on the basis of which conclusion were drawn and recommendations were proffered. In addition, the chapter discussed by outlying the contributions of the study to knowledge, the study outlined some suggestions for further research.

Summary

This study investigated the pedagogical content knowledge of public secondary school chemistry teachers in Bayelsa and Delta States with the aims of finding out: the content and pedagogical knowledge they demonstrate during lesson in the classroom, whether there is any relationship between content knowledge and teaching effectiveness and any relationship between pedagogical knowledge and teaching effectiveness. The study further examined the perceptions of: male and female chemistry teachers regarding their pedagogical content knowledge for teaching chemistry and male and female students regarding the pedagogical content knowledge of their chemistry teachers. In addition, the study investigated the perception of subject heads, chemistry teachers and principals regarding the strategies that could be adopted for enhanced development of pedagogical content knowledge for teaching. The study further ascertained the relationship between teachers' pedagogical content knowledge and teaching effectiveness of chemistry teachers in Bayelsa and Delta States secondary schools.

The study reviewed extensive literatures related to the topic of research in line with the independent and dependent variable investigated. Consequently, some key

concepts namely content knowledge, pedagogical knowledge, pedagogical content knowledge and teaching effectiveness were clarified. The study is delimited in scope to public secondary school having chemistry teachers in Bayelsa and Delta States, A sample of 789 respondents were drawn through simple random sampling technique from the public secondary schools in Bayelsa and Delta States. Eight research questions and six hypotheses were answered and tested respectively. The instrument comprised of demographic information (Section A), qualitative classroom observation guides (Sections B & C), and quantitative data (Sections D, E & F).The classroom observation guides were used to ascertain the content and pedagogical knowledge chemistry teachers in the two States demonstrate during lesson. The data collected using the classroom observation guides were converted into quantitative data for easy analysis in answer to research questions 1 and 2 and these research questions were not hypothesized. The rest research questions and their respective hypotheses were answered and tested by means of Sections D, E, and F instrument. Section H of the instrument was used to answer research question and test the hypothesis which focused on the strategies for enhanced development of chemistry teacher pedagogical content knowledge.

Descriptive statistics were employed for data analysis in answer to the eight research questions asked. The six null hypotheses formulated were tested using inferential statistics at 0.05 significant level.

The results of the study are as follows:

1. Public secondary school chemistry teachers in Bayelsa State and Delta State demonstrated good content knowledge in the classroom during lesson.
2. Public secondary school chemistry teachers in Bayelsa State and Delta State demonstrated good pedagogical knowledge during lesson in the classroom.
3. Male and female chemistry teachers in the two states have good pedagogical content knowledge for teaching the subjects.
4. The extent of teaching effectiveness of chemistry teachers in Bayelsa and Delta States were high in many aspects.
5. Sponsoring chemistry teachers to field trips and summer workshop attendance, building in professional development programmes in selected chemistry topics, mentoring less experienced chemistry teachers, regular classroom practice. and provision of current textbooks in the library are some of the strategies for enhanced development of pedagogical content knowledge of chemistry teachers,
6. There was a significant relationship between content knowledge and teaching effectiveness among chemistry teachers of public secondary schools in Bayelsa and Delta States.
7. There was a significant relationship between pedagogical knowledge and teaching effectiveness among public secondary schools chemistry teachers' in Bayelsa and Delta States.

8. There was a significant relationship between pedagogical content knowledge and teaching effectiveness among public secondary schools chemistry teachers in Bayelsa and Delta States.

Conclusion

Based on the findings, the study concludes that teaching effectiveness of chemistry teachers is anchored on their knowledge in terms of content, pedagogy and pedagogical content knowledge. The study also concludes that growth and development of teacher pedagogical content knowledge is dependent on the teacher's constant practice of teaching. It can also be concluded that there is a significant relationship between chemistry teachers' content, pedagogical and pedagogical content knowledge and their teaching effectiveness. The pedagogical content knowledge required for effective teaching of chemistry can be developed sustainably through several strategies.

Recommendations

Based on the findings and conclusion drawn, the following recommendations were made;

1. Government of Bayelsa and Delta States should formulate policies for continuous updating of knowledge of teachers through in-built professional development programmes on a regular basis for chemistry teachers in the States.
2. Government should as matters of urgency organize conferences for chemistry teachers which should focus on motivation theories and knowledge on how students learn. This is because in the area of

pedagogical knowledge, chemistry teachers in the two states are lacking in these aspects.

3. School principals in Bayelsa State should organize seminars for chemistry teachers on teaching methods periodically.
4. Principals in the two States should regularly visit the classroom during chemistry lesson and follow up classroom visitation and observation with dialogue with the teachers so as to help correct those who do not recognize slow learners and cater for different categories of learners during lesson.
5. Principals should ensure that they establish in-built formal school mentoring programmes in their schools where newly employed chemistry teachers will be under the guidance and supervision of older and more experienced teachers to help them grow in the teaching profession and develop adequate pedagogical content knowledge.

Contribution to Knowledge

The study contributed the following to existing body of knowledge in chemistry education;

1. The study proved empirically that chemistry teachers in Bayelsa and Delta States demonstrates good content knowledge during lesson in the classroom.
2. The study established that chemistry teachers in Bayelsa and Delta States demonstrated good pedagogical knowledge during lesson in the classroom.

3. The study confirmed the efficacy of content and pedagogical knowledge of chemistry teachers in enhancing their teaching effectiveness.
4. The study affirmed the association between pedagogical content knowledge and teaching effectiveness among chemistry teachers' in Bayelsa and Delta States.
5. It provided information on the various sources through which chemistry teachers can update their pedagogical content knowledge for effective teaching of the subject.

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APPENDIX A: THE INSTRUMENT

Chemistry Teachers Pedagogical Content Knowledge and their Teaching Effectiveness Questionnaire

Department of Curriculum and Integrated
Delta State University, Abraka
18th October, 2016.

Dear Respondents

The bearer is a Ph.D. student of the above-named department. I am currently conducting a study titled “An investigation on Chemistry Teachers Pedagogical Content Knowledge and their Teaching Effectiveness among Public Secondary Schools in Bayelsa and Delta States, Nigeria” The aim of the study is to find out the problems associated with the teaching of chemistry and advance possible solutions to the problems.

The questionnaire is therefore to solicit information from you in this regard. It is purely an academic exercise and as such information provided by you will be treated with utmost confidentiality. Please I need your cooperation.

Yours faithfully,

Asiyai, Anthony Asiyai.

SECTION A: RESPONDENTS DEMOGRAPHIC INVENTORY

Name of School:

State: Bayelsa () Delta ()

Gender of Teacher: Male () Female ()

Status: Principal () Subject Head () Teacher () Student ()

SECTION B

CLASSROOM OBSERVATION GUIDE: CONTENT KNOWLEDGE

NOTE: VA = Very Adequate, A = Adequate, IA = Inadequate, VI = Very Inadequate

S/N	Items on Content Knowledge	Responses			
		VA	A	IA	VI
1	Planning lesson in line with the topic to be taught or taught for each lesson				
2	Knowledge of chemistry generally				
3	Knowledge of simple laws underlying each topic in chemistry				
4	Knowledge of the content for each topic to be taught				
5	Application of chemistry principles underlying specific topic to be taught				
6	Knowledge of chemical theories				
7	Knowledge of chemistry concepts for specific topic				
8	Knowledge of entry behaviour for each chemistry topic				
9	Knowledge of instructional materials to be used when teaching specific topic in chemistry				

SECTION C

CLASSROOM OBSERVATION GUIDE: PEDAGOGICAL KNOWLEDGE

S/N	Items on Pedagogical Knowledge	Responses			
		VA	A	IA	VI
10	Clarity of behavioural objective				
11	Ability to start each specific lesson with good method				
12	Ability to relate topic with student s' level				
13	Ability to motivate students for their responses				
14	Teacher's use of appropriate teaching aids to enhance students' understanding				
15	Teacher's questioning approaches				
16	Knowledge of when to involve students in their learning				
17	Teacher's knowledge of teaching methods appropriate for each topic				
18	Ability to make judicious use of variety of teaching methods for different topics				
19	Teaching from simple terms to complex terms and from known to unknown				
20	Knowledge of how to evaluate students' learning				
21	Knowledge of an understanding of how students learn				

SECTION D

S/N	Items on Content Knowledge for Effective Teaching	Responses			
		SA	A	D	SD
22	Chemistry teacher knowledge of lesson planning enhances their teaching effectiveness				
23	Teachers sufficient knowledge of chemistry can enhance their effectiveness in teaching the subject				
24	Chemistry teachers who have enough knowledge of laws underlying each topic in the subject may teach it effectively				
25	Chemistry teachers' knowledge of the content for each topic to be taught can enhance effective teaching of the subject				
26	Chemistry teachers' ability to apply chemical principles underlying specific topic to be taught can enhance effective teaching of the subject				
27	Knowledge of chemical theories by chemistry teachers facilitates their teaching effectiveness				
28	Knowledge of chemistry concepts for specific topic can facilitate the teaching effectiveness of teachers				
29	Chemistry teachers' knowledge of entry behaviour for each chemistry topic can enhance their teaching effectiveness				
30	Chemistry teachers' knowledge of instructional materials to be used when teaching specific topic can enhance their teaching effectiveness				

SECTION E

Teachers' Pedagogical Knowledge for Effective Teaching Questionnaire

S/N	Items on Pedagogical Knowledge for Effective Teaching	Responses			
		SA	A	D	SD
31	Chemistry teacher's writing of clearly stated behavioural objective enhances his/her teaching effectiveness				
32	Ability to start each specific lesson with good method facilitates chemistry teachers' teaching effectiveness				
33	Ability to relate topic with student s' level enhances teaching effectiveness and students' understanding of topics				
34	Ability of chemistry teacher to motivate students for their responses can be a measure of teaching effectiveness				
35	Teacher's use of appropriate teaching aids to enhance students' understanding facilitates his/her effective teaching				
36	Teacher's questioning approaches enhances his/her teaching effectiveness				
37	Knowledge of when to involve students in their learning enhances his/her teaching effectiveness of teachers				
38	Chemistry teacher's knowledge of teaching methods appropriate for each topic enhances his/her teaching effectiveness				
39	Ability of chemistry teacher to make judicious use of variety of teaching methods for different topics enhances his/her teaching effectiveness				
40	Chemistry teaching from simple terms to complex terms and from known to unknown enhances teaching effectiveness of teachers				
41	Knowledge of how to evaluate students' learning enhances teaching of chemistry teachers				
42	Knowledge of an understanding of how students learn				

SECTION F

CHEMISTRY TEACHERS TEACHING EFFECTIVENESS QUESTIONNAIRE

Please indicate by ticking (X) in the space provided your opinion on your Chemistry Teachers Teaching Effectiveness

NOTE: SA = Strongly Agree, A = Agree, D = Disagree, SD = Strongly Disagree

S/N	Items on Chemistry Teachers Teaching Effectiveness	SA	A	D	SD
43	Careful planning of each lesson period				
44	Ability to communicate effectively with students during lesson				
45	Regular attendance at class				
46	Listening to students' opinions				
47	Provision of relevant feedback to students				
48	Use of relevant instructional materials for topics taught				
49	Gets students actively engaged during instruction				
50	Gives assignment that is relevant to topics taught				
51	Exhibits care and respect for students				
52	Clearly makes the objectives of lesson known to students				
53	Ability to apply variety of instructional strategies during lesson				
54	Ability to effectively manage the classroom				
55	Motivates students in their learning				
56	Ability to cover the curricula content outlined for each topic				
57	Ability to differentiate learning for individual students				
58	Socializes with students				
59	Demonstrates enthusiasm for students				
60	Demonstrates enthusiasm for subject matter				

SECTION G: QUESTIONNAIRE ON CHEMISTRY TEACHERS PCK

S/N	Perceptions of Students on Their Chemistry Teachers' Pedagogical Content Knowledge	Expression of Feelings			
		VA	A	IA	SIA
61	Ability to break down tasks when teaching for easy understanding				
62	knowledge of how to organize instruction to boost students' learning chemistry				
63	My teacher uses appropriate technical terms in chemistry when teaching				
64	Use multiple representations during chemistry lesson				
65	knowledge of chemical principles and laws				
66	knowledge of how to organize instruction to boost students' learning chemistry				
67	Knowledge of how to relate chemistry topics to natural occurrences when teaching				
68	My teacher has knowledge of both organic and inorganic chemistry				
69	My teacher knows how to teach both physical and practical chemistry				
70	Ability to give life examples when teaching chemistry				
71	My teacher uses variety of teaching methods during instruction				
72	Knowledge of how to recognize slow learners during instruction				
73	Ability to manage the classroom effectively when teaching				
74	Knowledge of how to rewards and motivates students during instruction				
75	knowledge of use of practical examples to manage students' behaviour				
76	Knowledge of students misconceptions during lesson				
77	Knowledge of students' conceptions chemistry lesson				
78	Knowledge of use of different innovative strategies to teach chemistry				
79	Knowledge of lesson presentation from concrete to abstract				
80	Knowledge of use of different questioning techniques during instruction				
81	Knowledge of how to present chemistry topics from simple to complex 7 from known to unknown				
82	Knowledge of students understanding of concepts taught during chemistry lesson				
83	Ability to cater for all categories of students				
84	Ability to create a positive classroom psychosocial learning environment				
85	Knowledge of formative evaluation techniques				
86	Knowledge of relevant teaching aids during chemistry lesson				
87	Ability to allow students to reflect on what we have learnt during lesson				
88	Knowledge of summative evaluation technique				
89	Ability to provide feedback to students during chemistry lesson				
90	Ability to provide timely feedback to students during lesson				
91	Ability to create a democratic classroom environment that allows students to express themselves freely				
92	Ability to control emotions during lesson				
93	Use of several approaches to engage and stimulate students' curiosity in learning chemistry				
94	Ability to understands students' misconception during lesson				
95	Giving relevant examples when teaching chemistry				
96	Ability to recognizes students' prior knowledge during lesson				
97	My teacher considers students' individual difference during lesson				
98	My teacher knows how to assess students' performance during lesson				
99	Knowledge of how to handle negative situations in the classroom				
100	Ability to uses assessment tools suitable for teaching topics in chemistry				

NOTE: Adapted from Aksu et al, 2014, Morrison & Luttenegger, (2015) PCK Scale

SECTION H
QUESTIONNAIRE ON STRATEGIES FOR ENHANCED DEVELOPMENT OF
CHEMISTRY TEACHERS PCK

S/N	Strategies for Improving Chemistry Teachers Development of PCK Questionnaire (SICTDPCKQ)	Expression of Feelings			
		SA	A	D	SD
101	Intensive in-service training for less experienced chemistry teachers on a regular basis				
102	In-built training workshops in chemistry within schools on a termly basis				
103	Building in professional development programmes in selected chemistry topics in school activities				
104	Linking teacher's professional development to students learning				
105	Mentoring of less experience chemistry teachers by head teachers				
106	STAN focusing conferences for chemistry teachers on difficult topics				
107	Sponsoring teachers on field trip to other schools to watch expert teachers teach difficult topics				
108	Empowering chemistry teachers through summer workshop attendance in other countries				
109	Private involvement in organizing chemistry education programmes for chemistry teachers				
110	Provision of current chemistry journals in school libraries				
111	Publishers of chemistry textbooks should concentrate on difficult topics in the subject				
112	Provision of current chemistry textbooks in school libraries				
113	Regular classroom practice				
114	Provision of visual games materials to enhance the teaching of chemistry				

APPENDIX B

CRON BACH'S ALPHA RELIABILITY COMPUTATION

/VARIABLES=CK1 CK2 CK3 CK4 CK5 CK6 CK7 CK8 CK9

/SCALE ('Content Knowledge for Effective Teaching') ALL

/MODEL=ALPHA

/STATISTICS=DESCRIPTIVE SCALE CORR

/SUMMARY=TOTAL.

Reliability

Scale: Content Knowledge for Effective Teaching

Case Processing Summary

		N	%
Cases	Valid	30	100.0
	Excluded ^a	0	.0
	Total	30	100.0

a. List wise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.814	.827	9

Item Statistics

	Mean	Std. Deviation	N
CK1	3.50	.682	30
CK2	3.70	.466	30
CK3	3.57	.774	30

CK4	3.43	.774	30
CK5	3.27	1.048	30
CK6	2.83	1.053	30
CK7	3.13	.937	30
CK8	3.67	.547	30
CK9	3.27	.907	30

Inter-Item Correlation Matrix

	CK1	CK2	CK3	CK4	CK5	CK6	CK7	CK8	CK9
CK1	1.000	.596	.229	.098	.386	-.024	.593	.185	.056
CK2	.596	1.000	.296	.468	.452	.035	.411	.406	.359
CK3	.229	.296	1.000	.267	.190	.458	.605	.217	.219
CK4	.098	.468	.267	1.000	.448	.346	.155	.516	.567
CK5	.386	.452	.190	.448	1.000	.541	.384	.582	.467
CK6	-.024	.035	.458	.346	.541	1.000	.373	.260	.409
CK7	.593	.411	.605	.155	.384	.373	1.000	.292	.119
CK8	.185	.406	.217	.516	.582	.260	.292	1.000	.533
CK9	.056	.359	.219	.567	.467	.409	.119	.533	1.000

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
CK1	26.87	19.361	.368	.618	.811
CK2	26.67	19.540	.552	.596	.799
CK3	26.80	18.234	.484	.517	.799
CK4	26.93	17.926	.535	.488	.793
CK5	27.10	15.403	.672	.666	.773
CK6	27.53	16.602	.504	.638	.800

CK7	27.23	16.944	.546	.645	.791
CK8	26.70	18.976	.579	.514	.794
CK9	27.10	17.334	.513	.475	.796

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
30.37	22.033	4.694	9

RELIABILITY

/VARIABLES=PK1 PK2 PK3 PK4 PK5 PK6 PK7 PK8 PK9 PK10 PK11 PK12

/SCALE ('Pedagogical Knowledge for Effective Teaching') ALL

/MODEL=ALPHA

/STATISTICS=DESCRIPTIVE SCALE CORR

/SUMMARY=TOTAL.

Reliability

Scale: Pedagogical Knowledge for Effective Teaching

Case Processing Summary

		N	%
Cases	Valid	30	100.0
	Excluded ^a	0	.0
	Total	30	100.0

a. List wise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.792	.791	12

Item Statistics

	Mean	Std. Deviation	N
PK1	3.57	.568	30
PK2	3.10	1.125	30
PK3	2.80	1.064	30
PK4	2.83	1.147	30
PK5	2.50	1.075	30
PK6	2.80	.887	30
PK7	2.93	1.081	30
PK8	2.80	1.126	30
PK9	2.40	1.070	30
PK10	2.83	1.053	30
PK11	3.53	.819	30
PK12	3.23	.935	30

Inter-Item Correlation Matrix

	PK1	PK2	PK3	PK4	PK5	PK6	PK7	PK8	PK9	PK10	PK11	PK12
PK1	1.000	.232	.422	.467	.310	.164	-.105	.022	-.045	.048	.291	-.128
PK2	.232	1.000	.450	.468	.214	.297	.119	.152	-.006	.073	.352	.272
PK3	.422	.450	1.000	.622	.543	.358	.408	.368	-.048	.154	.483	.083
PK4	.467	.468	.622	1.000	.406	.441	.130	.267	.084	.205	.428	.102
PK5	.310	.214	.543	.406	1.000	.434	.208	.199	.120	.442	.313	.566

PK6	.164	.297	.358	.441	.434	1.000	.274	.373	.196	.258	.294	.183
PK7	-.105	.119	.408	.130	.208	.274	1.000	.725	.322	.353	.080	.016
PK8	.022	.152	.368	.267	.199	.373	.725	1.000	.383	.262	-.067	-.020
PK9	-.045	-.006	-.048	.084	.120	.196	.322	.383	1.000	-.031	.220	.076
PK10	.048	-.073	.154	.205	.442	.258	.353	.262	-.031	1.000	.027	.321
PK11	.291	.352	.483	.428	.313	.294	.080	-.067	.220	.027	1.000	.372
PK12	-.128	.272	.083	.102	.566	.183	.016	-.020	.076	.321	.372	1.000

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
PK1	31.77	42.323	.270	.467	.791
PK2	32.23	37.978	.389	.452	.783
PK3	32.53	35.430	.638	.805	.756
PK4	32.50	35.362	.584	.584	.761
PK5	32.83	35.592	.616	.768	.758
PK6	32.53	37.844	.551	.409	.768
PK7	32.40	37.559	.447	.687	.776
PK8	32.53	37.016	.464	.705	.775
PK9	32.93	40.685	.206	.509	.801
PK10	32.50	39.293	.321	.464	.789
PK11	31.80	39.407	.444	.665	.778

PK12	32.10	40.162	.304	.706	.789
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Scale Statistics

Mean	Variance	Std. Deviation	N of Items
35.33	44.644	6.682	12

RELIABILITY

/VARIABLES=TE1 TE2 TE3 TE4 TE5 TE6 TE7 TE8 TE9 TE10 TE11 TE12 TE13 TE14 TE15 TE16 TE17 TE18

/SCALE('Chemistry Teachers' Teaching Effectiveness') ALL

/MODEL=ALPHA

/STATISTICS=DESCRIPTIVE SCALE CORR

/SUMMARY=TOTAL.

Reliability

Scale: Chemistry Teachers' Teaching Effectiveness

Case Processing Summary

		N	%
Cases	Valid	30	100.0
	Excluded ^a	0	.0
	Total	30	100.0

a. List wise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.867	.872	18

Item Statistics

	Mean	Std. Deviation	N
TE1	3.07	1.143	30
TE2	3.80	.484	30
TE3	3.23	1.073	30
TE4	3.70	.596	30
TE5	3.57	.504	30
TE6	3.30	.702	30
TE7	3.17	.950	30
TE8	3.20	.805	30
TE9	3.07	.828	30
TE10	3.30	.794	30
TE11	2.87	.937	30
TE12	3.23	.728	30
TE13	3.47	.776	30
TE14	2.80	1.031	30
TE15	2.97	.890	30
TE16	3.03	.850	30
TE17	3.13	.973	30
TE18	3.03	.999	30

Inter-Item Correlation Matrix

	TE1	TE2	TE3	TE4	TE5	TE6	TE7	TE8	TE9	TE1 0	TE1 1	TE1 2	TE1 3	TE1 4	TE1 5	TE16	TE1 7	TE1 8
TE1	1.000	.274	.240	.182	-.068	.533	.339	.322	.032	.243	.298	.105	.080	.334	.274	.565	.333	.028
TE2	.274	1.000	.159	.143	.057	.588	.450	.371	.465	.430	.167	.235	.440	.124	.144	.268	.498	.371
TE3	.240	.159	1.000	.275	.130	.133	.265	.303	-.057	.320	.341	.414	.403	.137	.117	.256	.200	.185
TE4	.182	.143	.275	1.000	.356	.470	.091	.417	.182	.051	.605	.167	.462	-.045	.436	.020	.547	.133
TE5	-.068	.057	.130	.356	1.000	.088	-.132	-.119	.072	.078	.165	.191	.270	-.106	-.033	-.046	.122	-.039
TE6	.533	.588	.133	.470	.088	1.000	.491	.500	.498	.266	.430	.061	.240	.086	.458	.329	.595	.280
TE7	.339	.450	.265	.091	-.132	.491	1.000	.451	.424	.526	.413	.590	.218	.317	.129	.334	.460	.466
TE8	.322	.371	.303	.417	-.119	.500	.451	1.000	.135	.065	.265	.271	.508	.216	.587	.494	.537	.420
TE9	.032	.465	-.057	.182	.072	.498	.424	.135	1.000	.336	.456	.374	.165	.218	.097	.193	.331	.497
TE1 0	.243	.430	.320	.051	.078	.266	.526	.065	.336	1.000	.472	.650	.157	.413	.015	.189	.482	.378
TE1 1	.298	.167	.341	.605	.165	.430	.413	.265	.456	.472	1.000	.401	.278	.328	.119	.136	.474	.410
TE1 2	.105	.235	.414	.167	.191	.061	.590	.271	.374	.650	.401	1.000	.289	.386	.172	.266	.490	.510
TE1 3	.080	.440	.403	.462	.270	.240	.218	.508	.165	.157	.278	.289	1.000	.034	.273	.080	.463	.468
TE1 4	.334	.124	.137	-.045	-.106	.086	.317	.216	.218	.413	.328	.386	.034	1.000	-.045	.519	.028	.074

TE1 5	.274	.144	.117	.436	-.033	.458	.129	.587	.097	.015	.119	.172	.273	-.045	1.000	.093	.483	.040
TE1 6	.565	.268	.256	.020	-.046	.329	.334	.494	.193	.189	.136	.266	.080	.519	.093	1.000	.244	.120
TE1 7	.333	.498	.200	.547	.122	.595	.460	.537	.331	.482	.474	.490	.463	.028	.483	.244	1.000	.563
TE1 8	.028	.371	.185	.133	-.039	.280	.466	.420	.497	.378	.410	.510	.468	.074	.040	.120	.563	1.000

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
TE1	54.87	63.706	.436	.701	.864
TE2	54.13	68.395	.541	.720	.861
TE3	54.70	65.045	.391	.616	.866
TE4	54.23	68.116	.456	.829	.862
TE5	54.37	72.033	.079	.594	.872
TE6	54.63	65.275	.634	.911	.856
TE7	54.77	62.599	.629	.822	.854
TE8	54.73	64.340	.617	.885	.855
TE9	54.87	66.326	.441	.820	.862
TE10	54.63	65.344	.544	.758	.858
TE11	55.07	63.030	.608	.805	.855
TE12	54.70	65.321	.604	.911	.857
TE13	54.47	66.257	.483	.717	.861
TE14	55.13	66.395	.328	.663	.868
TE15	54.97	67.275	.335	.821	.867
TE16	54.90	66.024	.450	.782	.862
TE17	54.80	61.200	.710	.839	.850

TE18	54.90	63.886	.505	.832	.860
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Scale Statistics

Mean	Variance	Std. Deviation	N of Items
57.93	72.961	8.542	18

RELIABILITY

/VARIABLES=SI1 SI2 SI3 SI4 SI5 SI6 SI7 SI8 SI9 SI10 SI11 SI12 SI13 SI14

/SCALE('Strategies for Improving Chemistry Teachers Development of PCK') ALL

/MODEL=ALPHA

/STATISTICS=DESCRIPTIVE SCALE CORR

/SUMMARY=TOTAL.

Reliability

Scale: Strategies for Improving Chemistry Teachers Development of PCK

Case Processing Summary

		N	%
Cases	Valid	30	100.0
	Excluded ^a	0	.0
	Total	30	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.797	.800	14

Item Statistics

	Mean	Std. Deviation	N
SI1	3.13	.507	30

SI2	2.90	.712	30
SI3	3.40	.563	30
SI4	3.20	.805	30
SI5	3.47	.629	30
SI6	3.40	.724	30
SI7	3.33	.606	30
SI8	3.03	.718	30
SI9	3.03	.890	30
SI10	3.13	.730	30
SI11	3.03	.718	30
SI12	2.70	.794	30
SI13	2.40	.894	30
SI14	2.40	.932	30

Inter-Item Correlation Matrix

	SI1	SI2	SI3	SI4	SI5	SI6	SI7	SI8	SI9	SI10	SI11	SI12	SI13	SI14
SI1	1.00 0	.134	.290	- .068	.231	.413	.187	.082	- .163	.136	.366	.017	- .122	.102
SI2	.134	1.00 0	.189	.277	.262	.147	.240	.546	.386	.623	.007	.128	.011	.010
SI3	.290	.189	1.00 0	.122	.428	.609	.404	.307	- .028	.285	.136	- .031	.151	.079
SI4	- .068	.277	.122	1.00 0	.014	.390	.424	.167	.087	.364	.227	.205	.077	.211
SI5	.231	.262	.428	.014	1.00 0	.182	- .060	.270	.341	.310	.346	.428	.331	.141
SI6	.413	.147	.609	.390	.182	1.00 0	.550	.106	- .182	.287	.172	.096	.224	.368

SI7	.187	.240	.404	.424	-.060	.550	1.000	.369	.043	.285	.132	-.072	.191	.366
SI8	.082	.546	.307	.167	.270	.106	.369	1.000	.430	.583	.065	.018	.301	.031
SI9	-.163	.386	-.028	.087	.341	-.182	.043	.430	1.000	.577	-.056	.259	.373	.233
SI10	.136	.623	.285	.364	.310	.287	.285	.583	.577	1.000	.057	.071	.285	.274
SI11	.366	.007	.136	.227	.346	.172	.132	.065	-.056	-.057	1.000	.562	.140	.288
SI12	.017	.128	-.031	.205	.428	.096	-.072	.018	.259	.071	.562	1.000	.417	.400
SI13	-.122	.011	.151	.077	.331	.224	.191	.301	.373	.285	.140	.417	1.000	.629
SI14	.102	.010	.079	.211	.141	.368	.366	.031	.233	.274	.288	.400	.629	1.000

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
SI1	39.43	28.254	.195	.493	.799
SI2	39.67	26.023	.418	.571	.785
SI3	39.17	26.971	.389	.604	.788
SI4	39.37	25.964	.360	.485	.790
SI5	39.10	26.162	.467	.566	.782
SI6	39.17	25.730	.451	.732	.782
SI7	39.23	26.461	.438	.617	.784
SI8	39.53	25.637	.469	.613	.781
SI9	39.53	25.568	.356	.638	.792
SI10	39.43	24.530	.622	.717	.768

SI11	39.53	26.533	.340	.593	.791
SI12	39.87	25.775	.392	.654	.787
SI13	40.17	24.557	.475	.652	.780
SI14	40.17	24.282	.480	.638	.780

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
42.57	29.564	5.437	14

APPENDIX C

Senior Secondary Schools & No. of Teachers in the Three Senatorial Districts of Delta State

S/N	Senatorial Districts	Local Government Area	No of Snr. Schs.	No of Teachers
	DELTA NORTH	Aniocha South	15	152
		Aniocha North	17	215
		Ika North-East	18	424
		Ika South	16	329
		Ndokwa East	16	78
		Ndokwa West	18	129
		Oshimili North	8	134
		Oshimili South	6	315
		Ukwuani	13	175
	DELTA SOUTH	Bomadi	8	39
		Burutu	15	64
		Isoko North	16	166
		Isoko South	18	156
		Patani	8	40
		Warri North	4	33
		Warri South	12	512
		Warri South-West	3	44
	DELTA CENTRAL	Ethiope East	21	256
		Ethiope West	11	140
		Okpe	11	147
		Sapele	13	357
		Udu	7	174
		Ughelli North	29	591
		Ughelli South	17	215
		Uvwie	8	400
	TOTAL	25	327	5285

APPENDIX D

Population of Senior Secondary Teachers Schools in Bayelsa State

S/N	Senatorial Districts	Local Govt. Area	No of Schools	No of Male Teachers	No of Female Teachers
1	Bayelsa East	Barass	10	19	28
		Ogbia	32	54	66
		Nembe	15	22	20
2	Bayelsa South West	Ekeremor	21	33	20
		Sagbama	24	30	48
		Silga	31	45	27
3	Bayelsa Central	Yenagoa	33	38	52
		Kolokumor/Opokuma	10	21	26
Total	3	8	176	262	287

APPENDIX E

Population of Secondary Schools in Bayelsa South West Senatorial District

S/N	Name of School	LGA
EKEREMOR ZONE		EKEREMOR
1	Govt Comprehensive Sec Sch Tamogbene	
2	Govt Sec Sch Ekeremor	
3	Govt Sec Sch Agge	
4	Community Sec Sch Bilabiri Izon Dodo	
5	Community Sec Sch Aleibiri	
6	Community Sec Sch Isanpou	
7	Community Sec Sch Ayamassa	
8	Community Sec Sch Ogbosuware	
9	Community Sec Sch Foutorugbene	
10	Community Sec Sch Obrigbene	
11	Community Sec Sch Norgbene	
12	Community Sec Sch Toru-Ndoro	
13	Community Sec Sch Peretorugbene	
14	Community Sec Sch Aghoro	
15	Govt Science Teacher College Aleibiri	
16	Esele Comprehensive School Amabulou	
17	Immaculate Comprehensive Secondary School Letugbene	
18	Immaculate Comprehensive Secondary School Egbemo Angalabiri	
19	Immaculate Comprehensive Secondary School Ogbotobo	
20	Ezetu Comprehensive Secondary School Azagbene	
21	Age Girls' Secondary School Agbidiana	
SILGA I ZONE		SILGA I
1	Government Sec Sch Amassoma	
2	Community Sec Sch Otuan	
3	Community Sec Sch Aguobiri	
4	Community Sec Sch Igeibiri	
5	Community Sec Sch Onyoma	
6	Community Sec Sch Obololi	

7	Community Sec Sch Boluo-Aguabiri	
8	Community Sec Sch Amassoma	
9	Community Sec Sch Ozezebiri	
10	Community Sec Sch Ekowe	
11	Community Sec Sch Diebu	
12	Community Sec Sch Igbomotoru	
13	Community Sec Sch Eniwari	
14	Community Sec Sch Peremabiri	
15	Community Sec Sch Kemeinama/Apumugbene	
16	Community Sec Sch Polobubou	
17	Community Sec Sch Okياما	
18	Community Sec Sch Angياما	
19	Community Sec Sch Fierebagha-Ama	
20	Tele Comprehensive Sec Sch Anyama-Ijaw	
21	Community Comprehensive Sec Sch Angياما	
22	Oge Grammar Sch Oweikorogha	
23	Oge Grammar Sch Amatolo	
24	Government Sec Sch Opuama	
	SILGA II ZONE	SILGA
1	Community Sec Sch Korokorosei	
2	Community Sec Sch Olugbobiri	
3	Community Sec Sch Ondewari	
4	Community Sec Sch Olugbororo	
5	Community Sec Sch Tebidaba	
6	Community Sec Sch Foropa	
7	Community Sec Sch Gbanraun	
8	Community Sec Sch Koluama I	
9	Community Sec Sch Ekeni	
10	Community Sec Sch Koluama II	
11	Community Sec Sch Lobia	
12	Community Sec Sch Azama	
13	Community Sec Sch Ukparatubo	
14	Community Sec Sch Keme-Ebياما	
15	Community Sec Sch Ogboinbiri	
16	Communit High Sch Azuzuama	
17	Community Comprehensive Sec Sch Ezetu	
18	Oweikorogha Community High Sch Ikebiri	
19	Age Grammar Sch Ukubie	
	SAGBAMA ZOME	SAGBAMA
1	River Noune Grammar Sch Agbere/Odoni	
2	Govet Comprehensive Sec Sch Tungbo	
3	Govt Sec Sch Toru-egbeni	
4	Mein Grammar Sch Ogobiri	
5	Community Sec Sch Trofani	
6	Community Sec Sch Sagbama	
7	Community Sec Sch Ofoni	
8	Community Sec Sch Angalabiri	
9	Community Sec Sch Asamabiri	
10	Community Sec Sch Angalabiri	
11	Community Sec Sch Bolou-Orua	
12	Community Sec Sch Adagbabiri	
13	Community Sec Sch Elemebiri	
14	Community Sec Sch Toru-Angياما	

15	Community Sec Sch Abuetor	
16	Community Sec Sch Osekwenike	
17	Community Sec Sch Okumbiri	
18	Community Sec Sch Kabeama	
19	Community Sec Sch Ossiana	
20	Community Sec Sch Akeddei	
21	Community Sec Sch Agorogbene	
22	Community Sec Sch Agoro	
23	Community Sec Sch Isoni	
24	Community Comprehensive Sec Sch Egbopuloama	

APPENDIX F

Population of Secondary Schools in Bayelsa East Senatorial District

S/N	Name of School	LGA
	BARASS ZONE	BARASS
1	Govt Sec Sch Twon Brass	
2	Govt Sec Sch Okpoama	
3	Govt Sec Sch Akassa	
4	Community Sec Sch Beletiana	
5	Community Sec Sch Beletiana II	
6	Community Sec Sch Egwama	
7	Community Sec Sch Minibie	
8	Community Sec Sch Liama	
9	Community Sec Sch Odioma	
10	Community Sec Sch Sangana	
	OGBIA ZONE	OGBIA
1	Marvelous Douglass High Sch	
2	Govt Sec Sch Ogbia Town	
3	Govt Sec Sch Anyama-Ogbia	
4	Govt Comprehensive Sec Sch Epebu	
5	Community Boys Sec Sch Emeyal	
6	Community Girls Sec Sch Emeyal	
7	Oloibiri Grammar Sch	
8	Otakeme Community Comprehensive Sec Sch Otakeme	
9	Okricn Community Sec Sch Emakalakala	
10	Community Sec Sch Kolo	
11	Community Sec Sch Otuasega	
12	Community Sec Sch Idema	
13	Community Sec Sch Otuoke/Otuaba	
14	Community Sec Sch Oruama	
15	Community Sec Sch Akipelai	
16	Community Sec Sch Amorokeni	
17	Community Sec Sch Otuogidi	
18	Community Sec Sch Onoebum	
19	Community Sec Sch Otookpoti	
20	Community Sec Sch Okodi	
21	Community Sec Sch Ologi	
22	Community Sec Sch Ewoi	
23	Community Sec Sch Otuedu	
24	Community Sec Sch Anyakoro	
25	Community Sec Sch Otuegwe I	
26	Community Sec Sch Otuegwe II	
27	Community Sec Sch Otuogori	
28	Community Sec Sch Okiki	
29	Community Sec Sch Otuobhi	
30	Community Comprehensive Sec Sch Elebele	
31	Community Comprehensive Sec Sch Opume	
32	Community Comprehensive Sec Sch Ologoghe	
	NEMBE ZONE	NEMBE
1	Nembe North Grammar School	
2	Community Sec Sch Okoroma	
3	Community Sec Sch Ewelesuo	

4	Community Sec Sch Ekperiama	
5	Community Sec Sch Oluasiri	
6	Community Sec Sch Okoroba	
7	Community Sec Sch Obioku	
8	Community Sec Sch Otimoama	
9	Community Girls Sec Sch Nembe	
10	Community Boys Sec Sch Nembe	

APPENDIX G

Population of Secondary Schools in Bayelsa Central Senatorial District

S/N	Name of School	LGA
	YENAGOA ZONE	YENAGOA
1	Govt Girls' Sec Sch Okolobiri	
2	Esele Community High Sch Tombia	
3	Ogbia Community High Sch Nedugo Agbia	
4	Biseni Community Sec Sch Biseni	
5	Oporoma Mein Grammar Sch Ikibiri	
6	Esist North High Sch Kpansia	
7	Bordelon Dio Grammar Sch Yenagoa	
8	St Judes Grammar Sch Amarata	
9	Community Comprehensive Sec Sch Agbuua	
10	Community Comprehensive Sec Sch Biogbolo/Yenezuegbne	
11	Community Sec Sch Agudama-Epie	
12	Community Sec Sch Famgbe	
13	Community Sec Sch Igbogene	
14	Community Sec Sch Okutukutu/ Etegwe	
15	Community Sec Sch Ikolo	
16	Community Sec Sch Azikoro	
17	Community Sec Sch Yenaka	
18	Community Sec Sch Akenfa	
19	Community Sec Sch Kpansai	
20	Community Sec Sch Yenegwe	
21	Community Sec Sch Swali	
22	Community Sec Sch Agudama-Ekpetiama	
23	Community Sec Sch Bumoundi	
24	Community Sec Sch Polaku	
25	Community Sec Sch Zarama	
26	Community Sec Sch Okordia	
27	Community Sec Sch Egbebiri-Biseni	
28	Community Sec Sch Ikarama	
29	Community Sec Sch Opolo	
30	Ode Grammar Sch Ogu	
31	Okoriana Community Sec Sch Koroama	
32	Community Comprehensive Sec Sch Okordia-North	
33	Community Girls' Sec Sch Agudama-Epie	
	KOLOKUMA/OPOKUMA ZONE	KOLOKUMA/OPOKUMA
1	Community Sec Sch Okoloba	
2	Community Sec Sch Sabagreia	
3	Community Girls' Sec Sch Odi	
4	Opokuma Senior Sec Sch Opokuma	
5	Sampou Grammar Sch Sampou	
6	Angadi Community Sec Sch Igbedi	
7	Govt Girls' Sec Sch Kaiama	
8	Opokuma Grammar Sch Opokuma	
9	Kingstay Grammar Sch Kaiama	
10	Govt Sec Sch Odi	

APPENDIX H

MEANS TABLES=CN1 CN2 CN3 CN4 CN5 CN6 CN7 CN8 CN9 BY State
/CELLS=COUNT MEAN STDDEV.

Means

Research Question 1: What content knowledge do secondary school chemistry teachers in Bayelsa and Delta States demonstrate during lesson in the classroom?

Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
Planning lesson in line with the topic to be taught or taught for each lesson * State	50	100.0%	0	0.0%	179	100.0%
Knowledge of chemistry generally * State	50	100.0%	0	0.0%	179	100.0%
Knowledge of simple laws underlying each topic in chemistry * State	50	100.0%	0	0.0%	179	100.0%
Knowledge of the content for each topic to be taught * State	50	100.0%	0	0.0%	179	100.0%
Application of chemistry principles underlying specific topic to be taught * State	50	100.0%	0	0.0%	179	100.0%
Knowledge of chemical theories * State	50	100.0%	0	0.0%	179	100.0%
Knowledge of chemistry concepts for specific topic * State	50	100.0%	0	0.0%	179	100.0%
Knowledge of entry behaviour for each chemistry topic * State	50	100.0%	0	0.0%	179	100.0%
Knowledge of instructional materials to be used when teaching specific topic in chemistry * State	50	100.0%	0	0.0%	179	100.0%

Report

	State					
	Bayelsa			Delta		
	N	Mean	Std. Deviation	N	Mean	Std. Deviation
Planning lesson in line with the topic to be taught or taught for each lesson	50	2.7	0.5	179	2.68	0.39
Knowledge of chemistry generally	50	2.69	0.56	169	3.43	0.47
Knowledge of simple laws underlying each topic in chemistry	50	2.25	0.34	179	2.87	0.37
Knowledge of the content for each topic to be taught	50	2.3	0.57	179	3.37	0.42
Application of chemistry principles underlying specific topic to be taught	50	2.63	0.46	179	2.68	0.31
Knowledge of chemical theories	50	3.43	0.57	179	2.86	0.57
Knowledge of chemistry concepts for specific topic	50	2.82	0.5	179	2.97	0.58
Knowledge of entry behaviour for each chemistry topic	50	3.67	0.37	179	2.79	0.65
Knowledge of instructional materials to be used when teaching specific topic in chemistry	50	3.29	0.47	179	2.98	0.58

Report

	State		
	Total		
	N	Mean	Std. Deviation
Planning lesson in line with the topic to be taught or taught for each lesson	179	2.63	.787
Knowledge of chemistry generally	179	3.42	.763
Knowledge of simple laws underlying each topic in chemistry	179	3.43	.615
Knowledge of the content for each topic to be taught	179	3.48	.610
Application of chemistry principles underlying specific topic to be taught	179	3.60	.518
Knowledge of chemical theories	179	3.45	.569
Knowledge of chemistry concepts for specific topic	179	3.43	.566
Knowledge of entry behaviour for each chemistry topic	179	3.39	.660
Knowledge of instructional materials to be used when teaching specific topic in chemistry	179	3.40	.571

MEANS TABLES=PK1 PK2 PK3 PK4 PK5 PK6 PK7 PK8 PK9 PK10 PK11 PK12 BY
 State
 /CELLS=COUNT MEAN STDDEV.

Means

Research Question 2: What pedagogical knowledge do secondary schools chemistry teachers in Bayelsa and Delta States demonstrate during lesson in the classroom?

Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
Clarity of behavioural objective * State	229	100.0%	0	0.0%	229	100.0%
Ability to start each specific lesson with good method * State	229	100.0%	0	0.0%	229	100.0%
Ability to relate topic with student s' level * State	229	100.0%	0	0.0%	229	100.0%
Ability to motivate students for their responses * State	229	100.0%	0	0.0%	229	100.0%
Teacher's use of appropriate teaching aids to enhance students' understanding * State	229	100.0%	0	0.0%	229	100.0%
Teacher's questioning approaches * State	229	100.0%	0	0.0%	229	100.0%
Knowledge of when to involve students in their learning * State	229	100.0%	0	0.0%	229	100.0%
Teacher's knowledge of teaching methods appropriate for each topic * State	229	100.0%	0	0.0%	229	100.0%
Ability to make judicious use of variety of teaching methods for different topics * State	229	100.0%	0	0.0%	229	100.0%
Teaching from simple terms to complex terms and from known to unknown * State	229	100.0%	0	0.0%	229	100.0%
Knowledge of how to evaluate students' learning * State	229	100.0%	0	0.0%	229	100.0%
Knowledge of an understanding of how students' learn * State	229	100.0%	0	0.0%	229	100.0%

Report

	State					
	Bayelsa			Delta		
	N	Mean	Std. Deviation	N	Mean	Std. Deviation
Clarity of behavioural objective	50	3.35	0.75	179	2.82	0.34
Ability to start each specific lesson with good method	50	3.2	0.32	179	2.76	0.64
Ability to relate topic with student s' level	50	3.1	0.47	179	2.69	0.59
Ability to motivate students for their responses	50	3.13	0.31	179	2.42	0.45
Teacher's use of appropriate teaching aids to enhance students' understanding	50	3.47	0.45	179	2.62	0.48
Teacher's questioning approaches	50	2.73	0.43	179	2.68	0.57
Knowledge of when to involve students in their learning	50	3.8	0.38	179	2.8	0.69
Teacher's knowledge of teaching methods appropriate for each topic	50	2.46	0.37	179	2.74	0.42
Ability to make judicious use of variety of teaching methods for different topics	50	2.67	0.48	179	2.72	0.68
Teaching from simple terms to complex terms and from known to unknown	50	2.86	0.38	179	2.74	0.79
Knowledge of how to evaluate students' learning	50	2.65	0.47	179	2.71	0.69
Knowledge of an understanding of how students' learn	50	2.95	0.62	179	2.08	0.48

Report

	State		
	Total		
	N	Mean	Std. Deviation
Clarity of behavioural objective	229	2.74	.967
Ability to start each specific lesson with good method	229	3.12	.817
Ability to relate topic with student s' level	229	3.18	.854
Ability to motivate students for their responses	229	3.22	.721
Teacher's use of appropriate teaching aids to enhance students' understanding	229	2.84	.946
Teacher's questioning approaches	229	3.10	.802
Knowledge of when to involve students in their learning	229	2.69	.929
Teacher's knowledge of teaching methods appropriate for each topic	229	2.89	.948
Ability to make judicious use of variety of teaching methods for different topics	229	2.95	.835
Teaching from simple terms to complex terms and from known to unknown	229	2.82	.888
Knowledge of how to evaluate students' learning	229	2.85	.967
Knowledge of an understanding of how students' learn	229	2.86	1.080

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Means

Research Question 3: What is the relationship between content knowledge and teaching effectiveness of chemistry teachers in Bayelsa and Delta States secondary schools?

```

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```

/STATISTICS DESCRIPTIVES
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```

Correlations

Descriptive Statistics

State		Mean	Std. Deviation	N
Delta State	Teaching Effectiveness	3.1477	.41440	232
	Content Knowledge	2.9631	.48209	232
Bayelsa State	Teaching Effectiveness	3.2508	.42347	224
	Content Knowledge	2.8620	.47988	224

Correlations

State			Teaching Effectiveness	Content Knowledge
Delta State	Teaching Effectiveness	Pearson Correlation	1	.215**
		Sig. (2-tailed)		.001
		N	232	232
Delta State	Content Knowledge	Pearson Correlation	.215**	1
		Sig. (2-tailed)	.001	
		N	232	232
Bayelsa State	Teaching Effectiveness	Pearson Correlation	1	.380**
		Sig. (2-tailed)		.000
		N	224	216
Bayelsa State	Content Knowledge	Pearson Correlation	.380**	1
		Sig. (2-tailed)	.000	
		N	224	216

** . Correlation is significant at the 0.01 level (2-tailed).

```

CORRELATIONS
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```

Research Question 4: What is the relationship between pedagogical knowledge and teaching effectiveness of chemistry teachers in Bayelsa and Delta States secondary schools?

Correlations

Descriptive Statistics

State		Mean	Std. Deviation	N
Delta State	Teaching Effectiveness	3.1477	.41440	232
	Pedagogical Knowledge	2.6471	.57373	232
Bayelsa State	Teaching Effectiveness	3.2508	.42347	224
	Pedagogical Knowledge	3.0314	.45341	224

Correlations

State			Teaching Effectiveness	Pedagogical Knowledge
Delta State	Teaching Effectiveness	Pearson Correlation	1	.229**
		Sig. (2-tailed)		.000
		N	232	232
Delta State	Pedagogical Knowledge	Pearson Correlation	.229**	1
		Sig. (2-tailed)	.000	
		N	232	232
Bayelsa State	Teaching Effectiveness	Pearson Correlation	1	.144*
		Sig. (2-tailed)		.035
		N	224	224
Bayelsa State	Pedagogical Knowledge	Pearson Correlation	.144*	1
		Sig. (2-tailed)	.035	
		N	224	224

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

Research Question 5: How do chemistry students in Bayelsa and Delta States public secondary schools assess their chemistry teachers' teaching effectiveness?

```
MEANS TABLES=TTE1 TTE2 TTE3 TTE4 TTE5 TTE6 TTE7 TTE8 TTE9 TTE10 TTE11
TTE12 TTE13 TTE14 TTE15 TTE16
TTE17 TTE18 BY State
/CELLS=COUNT MEAN STDDEV.
```

Means

Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
Careful planning of each lesson period * State	456	100.0%	0	0.0%	456	100.0%
Ability to communicate effectively with students during lesson * State	456	100.0%	0	0.0%	456	100.0%
Regular attendance at class * State	456	100.0%	0	0.0%	456	100.0%
Listening to students' opinions * State	456	100.0%	0	0.0%	456	100.0%
Provision of relevant feedback to students * State	456	100.0%	0	0.0%	456	100.0%
Use of relevant instructional materials for topics taught * State	456	100.0%	0	0.0%	456	100.0%
Gets students actively engaged during instruction * State	456	100.0%	0	0.0%	456	100.0%
Gives assignment that is relevant to topics taught * State	456	100.0%	0	0.0%	456	100.0%
Exhibits care and respect for students * State	456	100.0%	0	0.0%	456	100.0%
Clearly makes the objectives of lesson known to students * State	456	100.0%	0	0.0%	456	100.0%
Ability to apply variety of instructional strategies during lesson * State	456	100.0%	0	0.0%	456	100.0%
Ability to effectively manage the classroom * State	456	100.0%	0	0.0%	456	100.0%
Motivates students in their learning * State	456	100.0%	0	0.0%	456	100.0%

Ability to cover the curricula content outlined for each topic * State	456	100.0%	0	0.0%	456	100.0%
Ability to differentiate learning for individual students * State	456	100.0%	0	0.0%	456	100.0%
Socializes with students * State	456	100.0%	0	0.0%	456	100.0%
Demonstrates enthusiasm for students * State	456	100.0%	0	0.0%	456	100.0%
Demonstrates enthusiasm for subject matter * State	456	100.0%	0	0.0%	456	100.0%

Report

	State								
	Delta State			Bayelsa State			Total		
	N	Mean	Std. Deviation	N	Mean	Std. Deviation	N	Mean	Std. Deviation
	Careful planning of each lesson period	232	3.25	.505	224	3.52	.602	456	3.38
Ability to communicate effectively with students during lesson	232	3.39	.663	224	3.50	.709	456	3.44	.686
Regular attendance at class	232	3.22	.747	224	3.33	.728	456	3.27	.739
Listening to students' opinions	232	2.74	1.099	224	3.19	.946	456	2.95	1.052
Provision of relevant feedback to students	232	3.33	.746	224	3.37	.704	456	3.35	.726
Use of relevant instructional materials for topics taught	232	3.18	.910	224	3.26	.861	456	3.22	.887
Gets students actively engaged during instruction	232	3.19	.644	224	3.30	.692	456	3.24	.669
Gives assignment that is relevant to topics taught	232	3.17	.780	224	3.23	.802	456	3.20	.790
Exhibits care and respect for students	232	3.25	.826	224	3.19	.769	456	3.22	.799
Clearly makes the objectives of lesson known to students	232	3.12	.652	224	3.28	.793	456	3.20	.726
Ability to apply variety of instructional strategies during lesson	232	3.10	.677	224	3.18	.776	456	3.14	.726

Ability to effectively manage the classroom	240	3.05	.854	224	3.18	.850	456	3.11	.853
Motivates students in their learning	232	3.03	.833	224	3.21	.802	456	3.12	.822
Ability to cover the curricula content outlined for each topic	232	3.09	.787	224	3.12	.760	456	3.10	.773
Ability to differentiate learning for individual students	232	2.97	.742	224	3.21	.722	456	3.08	.742
Socializes with students	232	3.01	.816	224	3.14	.812	456	3.07	.816
Demonstrates enthusiasm for students	232	3.10	.753	224	3.12	.768	456	3.11	.760
Demonstrates enthusiasm for subject matter	232	3.46	.690	224	3.19	.765	456	3.34	.738

MEANS TABLES=PSPCK1 PSPCK2 PSPCK3 PSPCK4 PSPCK5 PSPCK6 PSPCK7 PSPCK8
PSPCK9 PSPCK10 PSPCK11 PSPCK12 PSPCK13 PSPCK14 PSPCK15 PSPCK16 PSPCK17
PSPCK18 PSPCK19 PSPCK20 PSPCK21 PSPCK22 PSPCK23 PSPCK24 PSPCK25 PSPCK26
PSPCK27 PSPCK28 PSPCK29 PSPCK30 PSPCK31 PSPCK32 PSPCK33 PSPCK34 PSPCK35
PSPCK36 PSPCK37 PSPCK38 PSPCK39 PSPCK40 BY State BY Gender
/CELLS=COUNT MEAN STDDEV.

Means

Research Question 6: How do male and female secondary school chemistry students in Bayelsa and Delta States perceive the pedagogical content knowledge of their chemistry teachers?

Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
My chemistry teacher have knowledge of learning theories * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher have knowledge of basic definitions in chemistry * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher uses appropriate technical terms in chemistry when teaching * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher uses multiple representations during chemistry lesson * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher have knowledge of chemical principles and laws * State * Gender	456	100.0%	0	0.0%	456	100.0%

My teacher applies chemical laws and principles where necessary during chemistry lessons * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher relates chemistry topics to natural occurrences when teaching * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher have knowledge of both organic and inorganic chemistry * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher knows how to teach both physical and practical chemistry * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher gives life examples when teaching chemistry * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher uses variety of teaching methods during instruction * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher recognizes slow learners during instruction * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher manages the classroom effectively when teaching * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher rewards and motivates students during instruction * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher uses practical examples to manage students' behaviour * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher is able to infer students misconceptions during lesson * State * Gender	456	100.0%	0	0.0%	456	100.0%
I can say the classroom is always calm during chemistry lesson * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teachers uses different innovative strategies to teach chemistry * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher uses humour to make chemistry lesson interesting to students * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher uses different questioning techniques during instruction * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher presents chemistry topics from simple to complex, from known to unknown, & from concrete to abstract * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher pays attention to each student during chemistry lesson * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher caters for all categories of students * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher creates a positive classroom psychosocial learning environment * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher's voice is audible during chemistry lesson * State * Gender	456	100.0%	0	0.0%	456	100.0%

My teacher uses relevant teaching aids during chemistry lesson * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher allows us to reflect on what we have learnt during lesson * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher encourages all students to participate actively during chemistry lesson * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher provides feedback to students during chemistry lesson * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher's feedback is always timely and accurate * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher creates a democratic classroom environment that allows students to express themselves freely * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher Ability to control emotions during lesson * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher uses several approaches to engage and stimulate students' curiosity in learning chemistry * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher understands students' misconception during lesson * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher gives relevant examples when teaching chemistry * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher recognizes students' prior knowledge during lesson * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher considers students' individual difference during lesson * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher knows how to assess students' performance during lesson * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher knows how to handle negative situations in the classroom * State * Gender	456	100.0%	0	0.0%	456	100.0%
My teacher uses assessment tools suitable for teaching topics in chemistry * State * Gender	456	100.0%	0	0.0%	456	100.0%

Report

	State																								
	Bayelsa									Delta									Total						
	Gender									Gender									Gender						
	Male			Female			Total			Male			Female			Total			Male			Female			Total
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N
My chemistry teacher have knowledge of learning theories	134	3.28	0.71	90	3.34	0.67	224	3.67	.549	138	3.09	0.68	94	3.13	0.74	232	3.05	1.181	272	2.82	.339	184	3.57	.645	456
My teacher have knowledge of basic definitions in chemistry	134	3.23	0.74	90	3.52	2.66	224	3.82	.442	138	3.24	0.66	94	3.20	0.75	232	3.62	.683	272	3.87	.437	184	3.59	.678	456
My teacher uses appropriate technical terms in chemistry when teaching	134	2.18	0.47	90	2.16	0.46	224	3.46	.742	138	2.46	0.66	94	2.59	0.75	232	3.54	.743	272	3.66	.679	184	3.42	.767	456
My teacher uses multiple representations during chemistry lesson	134	2.32	0.65	90	2.23	0.57	224	3.44	.763	138	2.50	0.70	94	2.59	0.74	232	3.49	.770	272	3.61	.696	184	3.38	.797	456
My teacher have knowledge of chemical principles and laws	134	2.50	0.72	90	2.39	0.67	224	3.72	.560	138	2.62	0.77	94	2.60	0.70	232	3.59	.683	272	3.79	.504	184	3.55	.701	456
My teacher applies chemical laws and principles where necessary during chemistry lessons	134	2.13	0.41	90	2.25	0.57	224	3.67	.606	138	2.39	0.62	94	2.43	0.71	232	3.27	.664	272	3.30	.618	184	3.49	.693	456
My teacher relates chemistry topics to natural occurrences when teaching	134	2.24	0.56	90	2.25	0.60	224	3.61	.629	138	2.58	0.81	94	2.57	0.77	232	3.18	.697	272	3.26	.602	184	3.40	.756	456
My teacher have knowledge of both organic and inorganic chemistry	134	2.98	0.75	90	3.07	0.77	224	3.68	.593	138	2.80	0.80	94	3.07	0.81	232	3.24	.677	272	3.35	.578	184	3.44	.738	456
My teacher knows how to teach both physical and practical chemistry	134	2.68	0.72	90	2.78	0.77	224	3.55	.654	138	2.72	0.77	94	2.85	0.83	232	3.16	.714	272	3.25	.634	184	3.34	.764	456

My teacher gives life examples when teaching chemistry	134	2.90	0.66	90	3.04	0.79	224	3.50	.721	138	2.96	0.78	94	3.17	0.75	232	3.14	.763	272	3.14	.706	184	3.36	.793	456
My teacher uses variety of teaching methods during instruction	134	3.11	0.72	90	3.22	0.75	224	3.37	.755	138	3.13	0.76	94	3.12	0.75	232	3.09	.687	272	3.11	.597	184	3.25	.792	456
My teacher recognizes slow learners during instruction	134	2.15	0.50	90	2.13	0.47	224	3.41	.817	138	2.54	0.78	94	2.60	0.79	232	3.12	.707	272	3.04	.653	184	3.34	.803	456
My teacher manages the classroom effectively when teaching	134	2.10	0.34	90	2.09	0.36	224	3.57	.669	138	2.64	0.81	94	2.60	0.79	232	3.41	.782	272	3.64	.668	184	3.36	.772	456
My teacher rewards and motivates students during instruction	82	2.28	0.61	90	2.22	0.53	224	2.99	.903	138	2.57	0.72	94	2.59	0.73	232	3.30	.798	272	3.41	.852	184	3.03	.817	456
My teacher uses practical examples to manage students' behaviour	82	2.40	0.68	90	2.24	0.51	224	3.22	.814	138	2.62	0.78	94	2.66	0.82	232	3.33	.773	272	3.41	.832	184	3.21	.753	456
My teacher is able to infer students misconceptions during lesson	82	2.11	0.42	90	2.17	0.50	224	3.17	.818	138	2.49	0.69	94	2.63	0.78	232	3.38	.734	272	3.44	.775	184	3.22	.758	456
I can say the classroom is always calm during chemistry lesson	134	2.17	0.49	90	2.19	0.51	224	3.42	.818	138	2.49	0.69	94	2.69	0.84	232	3.38	.752	272	3.59	.758	184	3.27	.764	456
My teachers uses different innovative strategies to teach chemistry	134	2.78	0.89	90	2.89	0.85	224	3.41	.722	138	3.06	0.75	94	3.01	0.78	232	3.45	.720	272	3.53	.749	184	3.38	.697	456
My teacher uses humour to make chemistry lesson interesting to students	134	2.31	0.62	90	2.33	0.61	224	3.34	.821	138	2.60	0.76	94	2.50	0.70	232	3.31	.738	272	3.12	.717	184	3.45	.774	456
My teacher uses different questioning techniques during instruction	134	2.07	0.38	90	2.13	0.46	224	3.56	.662	138	2.53	0.74	94	2.44	0.73	232	3.28	.725	272	3.12	.655	184	3.55	.701	456

My teacher presents chemistry topics from simple to complex, from known to unknown, & from concrete to abstract	134	3.18	0.77	90	3.34	0.80	224	3.47	.736	138	3.06	0.64	94	3.19	0.66	232	3.27	.785	272	3.07	.694	184	3.52	.771	456
My teacher pays attention to each student during chemistry lesson	134	3.21	0.72	90	3.16	0.81	224	3.49	.773	138	3.13	0.63	94	3.06	0.72	232	3.35	.747	272	3.18	.659	184	3.55	.783	456
My teacher caters for all categories of students	134	3.00	0.90	90	3.28	0.80	224	3.18	.900	138	2.93	0.87	94	3.20	0.82	232	3.36	.862	272	3.47	.849	184	3.18	.882	456
My teacher creates a positive classroom psychosocial learning environment	134	3.12	0.85	90	3.27	0.77	224	3.38	.779	138	2.94	0.79	94	3.14	0.86	232	3.37	.861	272	3.56	.796	184	3.26	.833	456
My teacher's voice is audible during chemistry lesson	134	3.01	0.79	90	3.18	0.73	224	3.69	.702	138	3.06	0.76	94	3.12	0.81	232	3.29	.753	272	3.37	.603	184	3.48	.843	456
My teacher uses relevant teaching aids during chemistry lesson	134	3.07	0.75	90	3.30	0.69	224	3.43	.763	138	2.98	0.71	94	2.96	0.78	232	3.12	.736	272	3.18	.643	184	3.28	.825	456
My teacher allows us to reflect on what we have learnt during lesson	134	2.99	0.82	90	3.23	0.79	224	3.54	.696	138	2.98	0.74	94	3.05	0.89	232	3.19	.695	272	3.25	.609	184	3.37	.773	456
My teacher encourages all students to participate actively during chemistry lesson	134	3.06	0.74	90	3.16	0.78	224	3.65	.638	138	3.09	0.71	94	3.12	0.80	232	3.21	.702	272	3.26	.613	184	3.44	.761	456
My teacher provides feedback to students during chemistry lesson	134	3.16	0.76	90	3.22	0.77	224	3.32	.810	138	3.39	0.73	94	3.54	0.64	232	3.10	.686	272	3.15	.614	184	3.20	.812	456
My teacher's feedback is always timely and accurate	134	3.18	0.77	90	3.34	0.80	216	3.32	.843	138	3.06	0.64	94	3.19	0.66	232	3.32	.837	272	3.54	.776	184	3.19	.849	456

My teacher creates a democratic classroom environment that allows students to express themselves freely	134	3.21	0.72	90	3.16	0.81	224	3.33	.872	138	3.13	0.63	94	3.06	0.72	232	3.30	.835	272	3.54	.783	184	3.16	.856	456
My teacher Ability to control emotions during lesson	134	3.00	0.90	134	3.28	0.80	224	3.32	.835	138	2.93	0.87	94	3.20	0.82	232	3.29	.801	272	3.48	.756	184	3.19	.829	456
My teacher uses several approaches to engage and stimulate students' curiosity in learning chemistry	134	3.12	0.85	90	3.27	0.77	224	3.37	.740	138	2.94	0.79	94	3.14	0.86	232	3.09	.622	272	3.05	.627	184	3.28	.702	456
My teacher understands students' misconception during lesson	134	3.01	0.79	90	3.18	0.73	224	3.32	.843	138	3.06	0.76	94	3.12	0.81	232	3.13	.611	272	3.05	.660	184	3.30	.727	456
My teacher gives relevant examples when teaching chemistry	134	3.07	0.75	90	3.30	0.69	224	3.71	.604	138	2.98	0.71	94	2.96	0.78	232	3.50	.669	272	3.69	.630	184	3.51	.658	456
My teacher recognizes students' prior knowledge during lesson	134	2.99	0.82	90	3.23	0.79	224	3.39	.758	138	2.98	0.74	94	3.05	0.89	232	3.47	.683	272	3.53	.763	184	3.38	.673	456
My teacher considers students' individual difference during lesson	134	3.06	0.74	90	3.16	0.78	224	3.19	.857	138	3.09	0.71	94	3.12	0.80	232	3.46	.811	272	3.45	.776	184	3.30	.871	456
My teacher knows how to assess students' performance during lesson	134	3.16	0.76	90	3.22	0.77	224	3.50	.736	138	3.39	0.73	94	3.54	0.64	232	3.55	.751	272	3.61	.673	184	3.48	.784	456
My teacher knows how to handle negative situations in the classroom	134	2.99	0.82	90	3.23	0.79	224	3.56	.618	138	2.98	0.74	94	3.05	0.89	232	3.54	.756	272	3.63	.653	184	3.49	.736	456
My teacher uses assessment tools suitable for teaching topics in chemistry	134	3.06	0.74	90	3.16	0.78	224	2.87	1.06	138	3.09	0.71	94	3.12	0.80	232	3.33	.942	272	3.42	.907	184	3.00	1.04 3	456

Means

Research Question 7: What strategies can be employed for enhanced development of chemistry teachers' pedagogical content knowledge for teaching the subject in Bayelsa and Delta States secondary schools?

Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
Intensive in-service training for less experienced chemistry teachers on a regular basis * Status	300	100.0%	0	0.0%	300	100.0%
In-built training workshops in chemistry within schools on a termly basis * Status	300	100.0%	0	0.0%	300	100.0%
Building in professional development programmes in selected chemistry topics in school activities * Status	300	100.0%	0	0.0%	300	100.0%
Linking teachers professional development to students learning * Status	300	100.0%	0	0.0%	300	100.0%
Mentoring of less experience chemistry teachers by head teachers * Status	300	100.0%	0	0.0%	300	100.0%
STAN focusing conferences for chemistry teachers on difficult topics * Status	300	100.0%	0	0.0%	300	100.0%
Sponsoring teachers on field trip to other schools to watch expert teachers teach difficult topics * Status	300	100.0%	0	0.0%	300	100.0%
Empowering chemistry teachers through summer workshop attendance in other countries * Status	300	100.0%	0	0.0%	300	100.0%
Private involvement in organizing chemistry education programmes for chemistry teachers * Status	300	100.0%	0	0.0%	300	100.0%
Provision of current chemistry journals in school libraries * Status	300	100.0%	0	0.0%	300	100.0%
Publishers of chemistry textbooks should concentrate on difficult topics in the subject * Status	300	100.0%	0	0.0%	300	100.0%
Provision of current chemistry textbooks in school libraries * Status	300	100.0%	0	0.0%	300	100.0%
Regular classroom practice * Status	300	100.0%	0	0.0%	300	100.0%
Provision of visual games materials to enhance the teaching of chemistry * Status	300	100.0%	0	0.0%	300	100.0%

Report

	State								
	Bayelsa			Delta			Total		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
Intensive in-service training for less experienced chemistry teachers on a regular basis	70	3.74	0.88	239	3.00	0.88	230	3.67	.510
In-built training workshops in chemistry within schools on a termly basis	70	3.43	0.73	239	3.20	0.54	230	3.78	.454
Building in professional development programmes in selected chemistry topics in school activities	70	3.22	1.11	239	2.98	0.43	230	3.75	.501
Linking teachers professional development to students learning	70	2.88	2.90	239	2.73	0.56	230	3.62	.546
Mentoring of less experience chemistry teachers by head teachers	70	3.62	0.55	239	3.50	0.34	230	3.70	.510
STAN focusing conferences for chemistry teachers on difficult topics	70	2.33	0.42	239	2.29	0.59	230	3.73	.510
Sponsoring teachers on field trip to other schools to watch expert teachers teach difficult topics	70	2.75	0.56	239	2.43	0.66	230	3.52	.765
Empowering chemistry teachers through summer workshop attendance in other countries	70	2.45	0.62	239	1.96	0.55	230	3.35	.618
Private involvement in organizing chemistry education programmes for chemistry teachers	70	2.85	0.50	239	2.66	0.38	230	3.76	.511
Provision of current chemistry journals in school libraries	70	3.40	0.46	239	3.60	0.55	230	3.56	.571
Publishers of chemistry textbooks should concentrate on difficult topics in the subject	70	2.22	0.58	239	2.12	0.65	230	3.02	.730

Provision of current chemistry textbooks in school libraries	70	3.54	0.69	239	3.40	0.59	230	3.71	.536
Regular classroom practice	70	2.10	0.72	239	2.20	0.62	230	3.49	.544
Provision of visual games materials to enhance the teaching of chemistry	70	1.24	0.98	239	2.11	0.77	230	3.12	1.05 1

CORRELATIONS

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/VARIABLES=Teaching_Effectiveness Pedagogical_Content_Knowledge
/PRINT=TWOTAIL NOSIG
/STATISTICS DESCRIPTIVES
/MISSING=PAIRWISE.

```

Research Question 8: What is the relationship between pedagogical content knowledge and teaching effectiveness among secondary school chemistry teachers in Bayelsa and Delta State?

Correlations

Descriptive Statistics

State		Mean	Std. Deviation	N
Delta State	Teaching Effectiveness	3.1477	.41440	232
	Pedagogical Content Knowledge	2.9127	.28266	232
Bayelsa State	Teaching Effectiveness	3.2508	.42347	224
	Pedagogical Content Knowledge	2.8468	.27916	224

Correlations

State			Teaching Effectiveness	Pedagogical Content Knowledge
Delta State	Teaching Effectiveness	Pearson Correlation	1	.737**
		Sig. (2-tailed)		.000
		N	232	232
Delta State	Pedagogical Content Knowledge	Pearson Correlation	.737**	1
		Sig. (2-tailed)	.000	
		N	232	232
Bayelsa State	Teaching Effectiveness	Pearson Correlation	1	.811**

	Sig. (2-tailed)		.000
	N	224	224
Pedagogical Content Knowledge	Pearson Correlation	.811**	1
	Sig. (2-tailed)	.000	
	N	224	224

** . Correlation is significant at the 0.01 level (2-tailed).

CORRELATIONS

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/VARIABLES=Content_Knowledge Teaching_Effectiveness
/PRINT=TWOTAIL NOSIG
/STATISTICS DESCRIPTIVES
/MISSING=PAIRWISE.

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Hypothesis 1: There will be no significant relationship between content knowledge and teaching effectiveness of chemistry teachers among public secondary schools in Bayelsa and Delta States.

Descriptive Statistics

State		Mean	Std. Deviation	N
Delta State	Teaching Effectiveness	3.1477	.41440	232
	Content Knowledge	2.9631	.48209	232
Bayelsa State	Teaching Effectiveness	3.2508	.42347	224
	Content Knowledge	2.8620	.47988	224

Correlations

State			Teaching Effectiveness	Content Knowledge
Delta State	Teaching Effectiveness	Pearson Correlation	1	.215**
		Sig. (2-tailed)		.001
		N	232	232
Delta State	Content Knowledge	Pearson Correlation	.215**	1
		Sig. (2-tailed)	.001	
		N	232	232
Bayelsa State	Teaching Effectiveness	Pearson Correlation	1	.380**
		Sig. (2-tailed)		.000
		N	224	224
Bayelsa State	Content Knowledge	Pearson Correlation	.380**	1
		Sig. (2-tailed)	.000	
		N	224	224

** . Correlation is significant at the 0.01 level (2-tailed).

```

CORRELATIONS
/VARIABLES=Teaching_Effectiveness Pedagogical_Knowledge
/PRINT=TWOTAIL NOSIG
/STATISTICS DESCRIPTIVES
/MISSING=PAIRWISE.

```

Hypothesis 2: There is no significant relationship between pedagogical knowledge and teaching effectiveness of chemistry teachers among public secondary schools in Bayelsa and Delta States.

Correlations

			Teaching Effectiveness	Pedagogical Knowledge
State				
Delta State	Teaching Effectiveness	Pearson Correlation	1	.229**
		Sig. (2-tailed)		.000
		N	232	232
	Pedagogical Knowledge	Pearson Correlation	.229**	1
		Sig. (2-tailed)	.000	
		N	232	232
Bayelsa State	Teaching Effectiveness	Pearson Correlation	1	.144*
		Sig. (2-tailed)		.035
		N	224	224
	Pedagogical Knowledge	Pearson Correlation	.144*	1
		Sig. (2-tailed)	.035	
		N	224	224

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

T-TEST GROUPS=State(1 2)
 /MISSING=ANALYSIS
 /VARIABLES=Teaching_Effectiveness
 /CRITERIA=CI(.95).

T-Test

Hypothesis 3: There is no significant difference between the mean perception scores of chemistry students in Bayelsa and Delta States public secondary schools regarding their chemistry teachers teaching effectiveness

Group Statistics

	State	N	Mean	Std. Deviation	Std. Error Mean
Teaching Effectiveness	Delta State	232	3.1477	.41440	.02675
	Bayelsa State	224	3.2508	.42347	.02881

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Teaching Effectiveness	Equal variances assumed	.958	.328	-2.625	454	.009	-.10309	.03927	-.18026	-.02591
	Equal variances not assumed			-2.622	446.767	.009	-.10309	.03932	-.18035	-.02582

```

DATASET ACTIVATE DataSet1.
SORT CASES BY State.
SPLIT FILE LAYERED BY State.
T-TEST GROUPS=Sex(1 2)
/MISSING=ANALYSIS
/VARIABLES=PCK
/CRITERIA=CI(.95).

```

T-Test

Hypothesis 4: There is no significant difference between the mean perception scores of male and female chemistry students in Bayelsa and Delta States with respect to their teachers' Pedagogical Content Knowledge for teaching chemistry.

Group Statistics

State	Sex	N	Mean	Std. Deviation	Std. Error Mean
Delta State	PCK Male	138	2.8801	.26018	.02309
	Female	94	2.9493	.30295	.02850
Bayelsa State	PCK Male	134	2.7896	.29360	.03242
	Female	90	2.8817	.26502	.02289

Independent Samples Test

State	Levene's Test for Equality of Variances		t-test for Equality of Means							
	F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		
								Lower	Upper	
Delta State	1.816	.179	-1.904	230	.058	-.06922	.03635	-.14084	.00240	
			-1.887	222.180	.060	-.06922	.03668	-.14150	.00306	
Bayelsa State	.733	.393	-2.378	222	.018	-.09208	.03872	-.16841	-.01575	
			-2.320	157.989	.022	-.09208	.03969	-.17048	-.01369	

T-TEST GROUPS=Status(1 2)
 /MISSING=ANALYSIS
 /VARIABLES=Strategies_for_Developing_Teachers'_PCK
 /CRITERIA=CI(.95).

Hypothesis 5: There is no significant difference between the mean perception scores of chemistry teachers and principals with respect to the strategies that could be adopted for enhanced development of pedagogical content knowledge(PCK) for teaching chemistry.

T-Test

Group Statistics

	Status	N	Mean	Std. Deviation	Std. Error Mean
Strategies for Developing	Principals	70	3.3661	.30862	.03450
Teachers' PCK	Teachers	239	3.6385	.35062	.02397

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Strategies for Developing	Equal variances assumed	.290	.591	-6.119	307	.000	-.27245	.04452	-.36008	-.18482
Teachers' PCK	Equal variances not assumed			-6.485	159.829	.000	-.27245	.04201	-.35542	-.18948

```

CORRELATIONS
/VARIABLES=Teaching_Effectiveness Pedagogical_Content_Knowledge
/PRINT=TWOTAIL NOSIG
/STATISTICS DESCRIPTIVES
/MISSING=PAIRWISE.

```

Correlations

Hypothesis 6: There is no significant relationship between pedagogical content knowledge and teaching effectiveness of chemistry teachers among public secondary schools in Bayelsa and Delta States.

Descriptive Statistics

State		Mean	Std. Deviation	N
Delta State	Teaching Effectiveness	3.1477	.41440	232
	Pedagogical Content Knowledge	2.9127	.28266	232
Bayelsa State	Teaching Effectiveness	3.2508	.42347	224
	Pedagogical Content Knowledge	2.8468	.27916	224

Correlations

State			Teaching Effectiveness	Pedagogical Content Knowledge
Delta State	Teaching Effectiveness	Pearson Correlation	1	.737**
		Sig. (2-tailed)		.000
		N	232	232
Delta State	Pedagogical Content Knowledge	Pearson Correlation	.737**	1
		Sig. (2-tailed)	.000	
		N	232	232
Bayelsa State	Teaching Effectiveness	Pearson Correlation	1	.811**
		Sig. (2-tailed)		.000
		N	224	224
Bayelsa State	Pedagogical Content Knowledge	Pearson Correlation	.811**	1
		Sig. (2-tailed)	.000	
		N	224	224

** . Correlation is significant at the 0.01 level (2-tailed).