UNIVERSITY OF EDUCATION, WINNEBA

INTEGRATED SCIENCE TEACHERS' PEDAGOGICAL CONTENT KNOWLEDGE AND ITS PERCEIVED IMPACT ON STUDENTS' ACHIEVEMENT

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A DISSERTATION IN THE DEPARTMENT OF SCIENCE EDUCATION, FACULTY OF SCIENCE EDUCATION SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES, UNIVERSITY OF EDUCATION, WINNEBA IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF MASTER OF EDUCATION IN SCIENCE EDUCATION OF THE UNIVERSITY OF EDUCATION, WINNEBA

2015

DECLARATION

STUDENT'S DECLARATION

I, ROBERT KWADWO SIEMOH declare that this dissertation with the exception of references contained in published works which have been duly identified and acknowledged, is entirely my own original work, and that it has neither in part nor whole been submitted for another degree elsewhere.

CANDIDATE'S SIGNATURE : ……………………………..

DATE : ……………………………….

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this dissertation was supervised in accordance with the guidelines on supervision of thesis laid down by the University of Education, Winneba.

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DATE : ………………………………………………

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DEDICATION

I dedicate this dissertation to the ALMIGHTY GOD and my parents.

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ABSTRACT

This study was designed to investigate the Pedagogical Content Knowledge of Integrated Science teachers, how it influences their teaching of the subject and its impact on students' achievement at the Junior High School level. The explanatory sequential mixed method design was used in this study. This is due to the fact that study was of quantitative priority where greater emphasis was placed on the quantitative method while the qualitative method played a secondary role. The research was carried out in four circuits and eight Junior High School selected at random from these circuits. The sample comprised 15 Integrated Science teachers and 124 Junior High School three (3) students. The main instruments used were questionnaire and observation schedule. Cronbach alpha (α) values of both teachers' and students' questionnaires were respectively found to be 0.72 and 0.68. The results showed that the Integrated Science teachers lack consistency among the components of Pedagogical Content Knowledge and this negatively affected their ability to present concepts well for students to comprehend. This could be the reason why the Junior High School graduates show mediocre scientific knowledge and perform poorly in Integrated Science in the Basic Education Certificate Examination.

It was also found out that the students perceived Integrated Science teachers' Pedagogical Content Knowledge to have a significant impact on their academic achievements in Integrated Science.

CHAPTER ONE

INTRODUCTION

1.0 Overview

In this chapter, the background to the study, statement of the problem and purpose of the study are deliberated on. It also provides objectives and research questions that directed the study. The significance, delimitations, limitations of the study and abbreviations are presented as well.

1.1 Background to the Study

The acquisition of general scientific literacy by every Ghanaian citizen is a requirement for successful living in modern times. Scientific culture develops and this aligns with the country's strategic programme of achieving scientific and technological literacy in the shortest possible time. This scientific culture is the antithesis to superstition and a catalyst for faster development (Curriculum Research Development Division, CRDD, 2012). Integrated Science therefore cannot be underrated in this 21st century when preparing students to be critical thinkers and have real-life problem- solving skills. Integrated science helps to raise the level of scientific literacy of the citizenry and equips them with the relevant basic integrated scientific knowledge needed for their own survival and for the development of the country. Students use critical thinking, self-assessment, reasoning, problem-solving, collaboration, research, and investigation to make connections in new and innovative ways as they progress through Integrated Science education (CRDD, 2012). Ghana's educational system has gone through a series of reforms since the colonial era. The main aim of these reforms is to bring improvement and relevance in the education of citizens. These reforms and changes in duration spent at the various levels of our educational system especially the Colleges of Education help to ensure higher content and important skills acquisition.

It is traditionally accepted that for any effective teaching, the teacher should have both the content knowledge and the pedagogy. Teachers' knowledge about the subject matter to be learned or taught and that of content to be covered in the syllabus as well the strategies to use to teach the subject are very important and when applied well will promote effective teaching and learning (Pihie & Sipon, 2013). A teacher with deep pedagogical knowledge understands how students construct knowledge and acquire skills and how they develop habits of mind and positive dispositions toward learning. As such, pedagogical knowledge requires an understanding of cognitive, social, and developmental theories of learning and how they apply to students in the classroom (Koehler & Mishra, 2009). One of the responsibilities of the Integrated Science teachers is to assist students to understand content of the subject. In doing so, Shulman (1986; 1987) put forward that teachers make use of pedagogical content knowledge (PCK), a special kind of knowledge that teachers have about how to teach particular content to particular students in ways that promote understanding. PCK influences teachers' teaching and impacts on students' academic achievement.

Teachers are generally considered to be the most essential elements in student learning and for that matter teachers' PCK, whether pre-service or in-service, is one of the most essential factors that affect the learning process (Karışan, Şenay & Ubuz, 2013).Therefore, learning is not accomplished through teacher's approach to teaching and learning but rather how the teacher will integrate curriculum content to teacher's own professional content knowledge to diverse interests and abilities of learners. The teacher is required to blend both the nature and the scope of the subject to achieve its purpose, goals and objectives.

In Ghana, Integrated Science is seen as one of the most important subjects in the Junior High School (JHS) curriculum and it is one of the core subjects studied at that level. Because of its importance as helping to solve the problems of life, the government of Ghana is committed to ensuring that quality and more Integrated Science teachers are produced by Universities and Colleges of Education. Even though Integrated Science at the JHS is compulsory for students, the researcher's personal experience and unproven information indicate that most JHS graduates' achievement in Integrated Science is low and do not demonstrate knowledge of the general aims enshrined in the Integrated Science Syllabus. Consistently, JHS graduates show lack of scientific curiosity, investigative habits and the use of scientific concepts and principles to solve problems of life. Also, they do not perform creditably well in Integrated Science during the BECE. The assertion above is supported by the analysed BECE results in the Atebubu-Amantin district from 2010-2014. This makes one begin to ask if Integrated Science as a subject in the JHS curriculum is actually achieving its purpose and goals.

General Science has been part of Ghana's educational system since colonial days. It is expected that the nation would have either produced or be producing JHS graduates with scientific curiosity, investigative habits and the use of scientific concepts and principles to solve problems of real life so that even when they are unable to further their formal education they would be able to effectively apply the knowledge and skills acquired in Integrated Science to solve daily life problems. But unfortunately this is not the case. The question therefore is why is it that the subject is not achieving its intended goals and purpose? Does it also mean that the teachers lack PCK in Integrated Science?

Many researchers have established that teachers' PCK influences how teaching is carried out in the classroom (Karışan, Şenay & Ubuz, 2013; Koehler & Mishra, 2009; Pihie & Sipon, 2013; Shulman, 1987). Andoh-Mensah (2013) posited that the efficiency of teaching is highly enriched by the pedagogy and content knowledge and therefore integrating teachers' content knowledge (CK) and pedagogical knowledge (PK) will produce a multidimensional and dynamic classroom context which is known as PCK leading to students' academic achievement. This idea informed the decision of the researcher to conduct a study into teachers' PCK in Integrated Science in Ghana, specifically in the Atebubu-Amantin district in the Brong Ahafo region.

1.2 Statement of the Problem

Ever since the inception of Integrated Science (General Science) many JHS leavers rather show mediocre scientific knowledge contrary to the goals and objectives of the subject. Also, most of these students underperform in class texts, terminal examinations and even public examinations, the Basic Education Certificate Examinations (BECE). This is evident in results of the BECE Integrated Science over the years. For instance, a critical look at the performance of students in the BECE in Integrated Science in the Atebubu-Amantin district from 2010-2014 shows little or no improvement in the performance of students. The number and percentages of candidates awarded grade 6-9 (failed) in Integrated Science were as follows: in 2010, 535 students failed out of the 971 students who wrote the exams representing 55.20%; 2012, 300 students out of the 874 students failed with percentage of 33.56%; 2013, 554 students failed out of 1019 students and the percentage fail was 54.37 and in

2014, 533 students out of the 1154 who wrote the exams failed with percentage of 46.19% (GES, 2010-2014). From the figures or percentages given, it shows that the performance of JHS students in Integrated Science has not seen much significant improvement over the years.

According to Botha & Reddy (2011) when a concept is seen mostly as theoretical it is normally not actively introduced into the curricula of teacher training programmes. This can make the concept seem to be far removed from the daily practice and conceptual framework of teachers leading to poor presentation of instruction with less impact on students' achievement. This assertion, the researcher believes is what is currently happening in Ghana. PCK has not been emphasised in our curriculum and it is therefore not portrayed in classrooms. Most educational researchers in Ghana have kept silent on the significance of PCK in students' achievement and educational development. This, in the researchers' view, is the cause of the low performance of JHS graduates particularly in Integrated Science and their lack of scientific literacy. From these submissions, it is very clear that PCK is essential for all teachers. Students' success depends on what the teacher knows about a subject and how he or she can impart this to the students. There is therefore the need to study the PCK of teachers in subject-specific areas like Integrated Science to find out whether it influences teachers' instruction and students' academic achievement.

This development informed the decision of the researcher to conduct a study into Integrated Science teachers' pedagogical content knowledge and how their students perceived its impact on their achievement in Ghana, specifically in the Atebubu-Amantin district in the Brong Ahafo region.

1.3 Purpose of the Study

The purpose of the study was to investigate the PCK of Integrated Science teachers, how it influences their teaching of the subject and its perceived impact on students' achievement at the Junior High School level.

1.4 Objectives of the Study

The objectives of the study were to:

1. Investigate the PCK level of Integrated Science teachers' at the Junior High School in the Atebubu-Amantin district.
2. Identify how Integrated Science teachers' in the Atebubu-Amantin District PCK influenced their teaching.
3. Find out how students perceived the impact of Integrated Science teachers' PCK on their achievements in Integrated Science.

1.5 Research Questions

The research questions that guided this study were:

1. What is the PCK level of Junior High School Integrated Science teachers' in the Atebubu-Amantin District?
2. How does the PCK of Integrated Science teachers' in the Atebubu-Amantin District influence their teaching?
3. How do students perceive the impact of the PCK of Integrated Science teachers' in the Atebubu-Amantin District on their achievements in Integrated Science?

1.6 Significance of the Study

The rationale for teaching Integrated Science as part of the Junior High School curriculum is for every Ghanaian citizen to acquire a basic scientific literacy for successful living in this modern time. The Integrated Science syllabus is a conscious effort to raise the level of scientific literacy of all students and equip them with the relevant basic Integrated Scientific Knowledge needed for their own survival and for the development of the country.

In this study, the researcher endeavoured to establish the significance of PCK, its influence on teachers' teaching and its impact on students' achievement in Integrated Science. Such findings will inform Tertiary Institutions that run teacher education programmes on the need to modify their Integrated Science curricula to suit what the Ministry of Education expects at the JHS level. Also, teachers who teach Integrated Science would know the relevance of PCK for the teaching of Integrated Science. The Ghana National Association of Science Teachers would also be informed by this study to improve upon its members PCK by organising INSET for them. This will help them to teach to reflect the nature, scope, goal and objectives of the subject and also enhance students' performance.

1.7 Delimitations of the Study

Marilyn (2011) explained delimitations as those characteristics that limit the scope and define the boundaries of the study. According to him delimitations are in the control of the researcher. Delimiting factors may include the choice of objectives, the research questions, variables of interest, theoretical perspectives that the researcher adopted (as opposed to what could have been adopted), and the population he/she chooses to investigate.

Although the study area included the whole of the Brong Ahafo Region the researcher restricted himself to Atebubu-Amantin district. The researcher delimited the study to one District to enable him do an in-depth study. For the same reason he delimited the number of teachers who participated to fifteen. Again, only JHS 3 students were used because they had stayed longer in the school and had been taught for three years by these teachers. Therefore, there were considered in a better position to answer the questionnaire than the other students.

1.8 Limitations to the Study

The researcher recognises the limitations of the instruments used in soliciting respondents' views on the research topic. The major limitation was that the closed ended questionnaire may not have given respondents the opportunity to give their views precisely as was desired. This effect was nonetheless minimised by the use of instruments like observation schedule. The conclusion based on the major findings was therefore limited to only Atebubu-Amantin District. Thus generalisation of the findings of the study to cover all Integrated Science teachers in the country is impossible.

1.9 Abbreviations

PCK = Pedagogical Content Knowledge

MOE = Ministry of Education

JHS = Junior High School

BECE = Basic Education Certificate Examination

NSTA = National Science Teachers Association

CRDD = Curriculum Research Development Division

CK = Content Knowledge

PK = Pedagogical knowledge

INSET = In-service Training

GES = Ghana Education Service

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter reviews the literature related to the issues that are relevant to the study. The review is based on the following: Integrated Science in the Ghanaian educational curriculum, Theoretical framework of the study, pedagogical content knowledge (PCK), description of PCK, conceptualisation of PCK, the place of PCK in science education, influence of teachers' PCK on their teaching, impact of teachers PCK on students' achievement, measuring PCK, teaching of Integrated Science, summary of literature review and organisation of subsequent chapters.

2.1 Background of Integrated Science

Integrated Science is the type of science in which emphasis is placed on the holistic study of science. Bajah (as cited in Afuwape, 2006) defined Integrated Science as an approach to the teaching of science in which concepts and principles are presented so as to express the fundamental unity of scientific thought and avoid premature or undue stress on the distinctions between the various scientific fields.

According to Arbon (as cited in Opara, 2011) "Integration", when applied to science subjects, means that the subject is planned and presented in such a way that students gain the concept of the fundamental unity of science; the commonality of approach to problems of a scientific nature; and are helped to gain an understanding of the role and function of science in everyday life, and the world in which they live. He added that, integrating principles are intended to produce a subject which is relevant to student needs and experiences, stresses to fundamental unity of science, and lays adequate foundations for subsequent specialist study. In other words, Integrated Science has been offered as a way to increase scientific literacy, the processes of science, increase interest in science, meet learners' needs, maintain flexibility and show the relationship of science and society.

Integrated Science as a subject eliminates the repetition of subject matter from the various sciences and does not recognize the traditional subject boundaries when presenting topics or theme

The Integrated Science curriculum in most countries is geared to cater for all levels of ability in students who are all potentially useful citizens of the future. With integrated science, those students who are weak in science and cannot continue with science in school will have had an exposure to science which can hopefully assist them to contribute intelligently in the technical, agricultural and other sectors of the nation. The acquisition of general scientific literacy by every Ghanaian citizen is a requirement for successful living in modern times. Scientific culture develops and this aligns with the country's strategic programme of achieving scientific and technological literacy in the shortest possible time. Attaining a scientific culture as a people will eliminate superstition and help in faster development of Ghana (CRDD, 2012).

The study of Integrated Science according to CRDD (2012) will provide excellent opportunities for the development of positive attitudes and values in learners which include: curiosity to explore their environment and question what they find; keenness to identify and answer questions through investigations, creativity in suggesting new and relevant ways to solve problems; open-mindedness to accept all knowledge as tentative and to change their view if the evidence is convincing; perseverance and patience in pursuing a problem until a satisfying solution is found; concern for living things and awareness of the responsibility they have for quality of the environment; honesty, truthfulness and accuracy in recording and reporting scientific information and love, respect and appreciation for nature and desire to conserve natural balance.

The framework on which integrated science education is built hinges on three areas as follows inquiry, concern and the ability to solve real problems. The spirit of scientific inquiry revolves around curiosity, while concern for others is associated with compassion which grows out of accumulated sets of attitudes acquired through participation in the scientific enterprise (Opara, 2014). Since the students are capable of logical and rational thinking (Lewis, 1978), they are also idealistic and caring people and it is probably at this stage of their lives that concern and compassion for others can be imbued. In addition, they can be made aware of the doctrine of social responsibility and morality in science.

Alles and Baez, 1973 (as cited in Opara, 2014) said there is a growing awareness that the adoption of the integrative approach to school science could serve the realization of the goals of general education better. This is more so when the concern of science teaching is widened to include the ability to solve real problems. The ability to solve real problems means competence. Indeed, solving problems require making value judgments and taking decisions. This in turn involves making choices considering the complex interaction of science and technology on one hand and society, culture and environment on the other. The exercise of choice in relation to scientific activities is an act of great responsibility. The three concepts, curiosity, compassion and competence are inextricably linked to each other. Moreover, they constitute important aspects of the general education of the individual. Incorporating them into an integral science programme for the schools is very important.

According to Adeoye, Bandele, Okoronka and Raimi (n.d.), when subject specialist teachers are confronted with the teaching of Integrated Science, there is always the evidence of bias towards their own special discipline. For instance, a Biology teacher may treat the Biology section of the Integrated Science well than the other sections on Chemistry, Physics and Agriculture. In view of the unfortunate state of affairs in Integrated Science classes as stated above, there is the need for an entirely new philosophy and approach to Integrated Science (Adeoye, Bandele, Okoronka & Raimi, n.d.). Quartey (2003) posited that the philosophy of a subject is the main core that links the content, teaching and assessment of that subject. Appropriate teaching techniques and assessment procedures depend to a large extent on what the subject stands for. Therefore, in order to realize the aims for studying Integrated Science in Ghana the teachers of the subject need to have a clear understanding of how to present it. Effective teaching of Integrated Science requires that its teachers hold perceptions that fall in line with what the subject is intended for. This means that, effective teaching of Integrated Science requires PCK which will at the end inculcate in students the scientific way of life through curiosity and investigative habits and also problem solving skills and improve their academic achievement. For instance, teachers of Integrated Science do not only need to teach to test but also need to know how to use illustrations, charts, models or diagrams to represent Integrated Science concepts to students, provide students with information that will make them open-minded and critical thinkers with real life problem solving skills. This is possible with the acquisition of PCK.

2.2 The Theoretical Framework of the Study

The theoretical framework for this study is inferred from Shulman's formulation of "Pedagogical Content Knowledge". The researcher has applied Shulman's theory by extending it to the situation of teachers amalgamating both content and pedagogy for effective teaching and learning. The theoretical framework builds on Shulman's (1986; 1987) descriptions of PCK to show how teachers' content knowledge and PCK interact with one another to produce effective teaching. He claimed that the emphases on teachers' subject knowledge and pedagogy were being treated as mutually exclusive domains in research concerned with these domains (Shulman, 1987). According to him, the practical consequence of such exclusion was the production of teacher education programmes in which a focus on either subject matter or pedagogy dominated.

To address this anomaly, he proposed a consideration of the necessary relationship between the two by introducing the notion of PCK. This knowledge includes knowing what teaching approaches fit the content, and likewise, knowing how elements of the content can be arranged for better teaching. This knowledge is different from the knowledge of a disciplinary expert and also from the general pedagogical knowledge shared by teachers across disciplines (Baxter, Leinhardt & Stein, 1990). PCK is concerned with knowledge of teaching strategies that incorporate appropriate conceptual representations, to address learner difficulties and misconceptions and foster meaningful understanding (Mahmoud & Seleim, 2013). It also involves the representation and formulation of concepts, pedagogical techniques, as well as knowledge of students and theories of epistemology (Smith, 2013). This knowledge of students includes their prior conceptions (both "naïve" and instructionally produced); misconceptions students are likely to have about a particular domain and potential misapplications of prior knowledge (Reyes, 2013). It also includes knowledge of what the students bring to the learning situation, knowledge that might be either facilitative or dysfunctional for the particular learning task at hand (Baxter, Leinhardt, Putnam, & Stein, 1991). PCK exists at the intersection of content and pedagogy (Mishra & Koehler, 2006). Therefore, it does not refer to a simple consideration of both content and pedagogy in isolation; but rather to an amalgam of content and pedagogy thus enabling transformation of content into pedagogically powerful forms (Andoh-Mensah, 2013). PCK represents the blending of content and pedagogy into an understanding of how particular aspects of subject matter are organized, adapted, and represented for instruction (Mishra & Koehler, 2006). Shulman, (as cited by Nuangchalerm, 2012) argued that having knowledge of subject matter and general pedagogical strategies, though necessary, were not sufficient for capturing the knowledge of good teachers. To characterize the complex ways in which teachers think about how particular content should be taught, he argued for “pedagogical content knowledge” as the content knowledge that deals with the teaching process, including “the ways of representing and formulating the subject that make it comprehensible to others” (Lumadi, 2012).

If teachers were to be successful they would have to confront both issues (of content and pedagogy) together, by embodying the aspects of content most relevant to its teachability (Shulman, 1987, as cited in Soare, 2013). At the heart of PCK is the manner in which subject matter is transformed for teaching (Mishra & Koehler, 2006). This occurs when the teacher interprets the subject matter, finds different ways to represent it and makes it accessible to learners (Akinlaye, 1997). Thus, there is a connection between teachers’ PCK and effective teaching and learning which when well incorporated will help in achieving the purpose and goals Integrated Science seeks to achieve.

2.3 Pedagogical Content Knowledge (PCK)

Teaching is a multifaceted cognitive skill going on in an ill-structured, dynamic environment (Coulson, Feltovich, Jacobson & Spiro (1991), as cited in Kereluik, Koehler & Mishra, 2010). Expertise in teaching is dependent on flexible access to highly organized systems of knowledge (Borko & Putnam, 2000). Teachers are expected to possess certain knowledge bases to be effective in their work. PCK is important in teacher education; it is a knowledge base for teaching (Van Driel, Verloop & de Vos, 1998). These initially included, Content knowledge, Pedagogical knowledge, knowledge of curriculum, knowledge of learners, and knowledge of assessment. In 1987, Shulman introduced the idea of Pedagogical Content Knowledge as essential for teacher professionalism. He further argued that possessing knowledge of subject matter and teaching strategies was not enough for capturing the knowledge of good teachers. To illustrate the complicated ways in which teachers think about how particular content should be taught he put forward PCK as the content knowledge that emphasizes the teaching process, as well as the "ways of representing and formulating the subject that make it comprehensible to learners" (p. 9).

2.3.1 Descriptions of PCK

PCK according to Falk (2011) was first introduced as the dimension of subject matter knowledge for teaching by Shulman. Shulman (1987) considered PCK as a special amalgamation of content and pedagogy that is especially the province of teachers, their own special form of professional understanding. Shulman (1987) therefore defined PCK as an "understanding of how particular topics, problems, or issues are organized, presented, and adapted to the diverse interests and abilities of learners, and presented for instruction" (p.8). PCK embodies the amalgamation of content and pedagogy into an understanding of how certain aspects of subject matter are organized, adapted, and represented for instruction. The efficacy of Integrated Science teachers therefore depends on how they are able to blend the subject matter (content) and pedagogy to include facets of content which are relevant to the enactment of PCK (Koehler & Mishra, 2006). This when successful, influences the teachers' instruction positively and also impacts on students' achievement in Integrated Science leading to the realisation of the aims of the Integrated Science curriculum. PCK is a characteristic of teacher knowledge on how to teach the subject matter (Chai, Koh & Tsait, 2010).

Oliver and Park (2014) viewed PCK as a specialised knowledge for teachers. They later wrote that PCK is teachers' understanding and enactment of how to assist students to comprehend particular subject matter by means of many instructional approaches, illustrations, and assessments not forgetting setbacks in the learning environment. This means that PCK for effective teaching is the integration of all aspects of teacher knowledge in a highly complex way. PCK is specifically for professional teachers because it guides the teachers' actions when dealing with subject matter in the classroom (De Jong, Van Driel & Verloop, 2002). It is a particular body of knowledge of teachers required to perform successfully in teaching within complex and varied contexts (Oliver & Park, 2007). PCK is the knowledge that teachers develop over time, and through experience, about how to teach a particular content in particular ways to lead to enhanced student understanding (Koehler, 2011). PCK is not a single entity that is the same for all teachers of a given subject area. It is particular expertise with individual idiosyncrasies and significant differences that is influenced by (at least) the teaching context, content, and experience (Koehler, 2011). PCK stands out as different and distinct from knowledge of pedagogy, or knowledge of content alone.

PCK is a form of practical knowledge that is used by teachers to guide their actions in highly contextualized classroom settings (Koehler, 2011). It is not just the knowledge of the subject matter but include the understanding of learning difficulties, and student conceptions. No matter how brilliant a teacher may be, the moment he or she could not interpret the subject-matter knowledge to facilitate student learning he or she has not achieved anything. Therefore, PCK is referred to as teachers' interpretations and transformation of knowledge of subject matter to facilitate student learning (Van Driel, Verloop & de Vos, 1998). PCK is a heuristic for teacher knowledge that can be useful in changing the complexities of what teachers know about teaching and how it changes over broad spans of time (Plasma & Schneider, 2011). Assessment is vital to teaching and learning. Based on this fact Falk (2011) observed that PCK is an important resource for teachers engaging in formative assessment. PCK according to Nuangchalerm (2012) can combine knowledge of a particular discipline along with teaching of that discipline. He further stressed the need for the teacher to be able to blend CK with PK stating that teachers' content knowledge or pedagogical knowledge alone does not contribute to their professional development unless the two merged (Nuangchalerm, 2012). PCK is considered by Oliver and Park (2008) to be a knowledge of teaching that is domain specific. It is making what teachers know about their subject matter known to students. Plasma & Schneider (2011) underscored the importance of PCK to teaching and learning as a construct to help our thinking about what teachers continue to learn as they study their teaching practice. Grossman, 1990 (as cited in Lasley & Ornstein, 2000) put forward that for novice teachers to be effective, they must struggle simultaneously with issues of pedagogical content knowledge as well as general pedagogy or generic teaching principles. The descriptions of PCK leads to how it has been conceptualised by researchers.

2.3.2 Conceptualisation of PCK

PCK has been conceptualised in diverse ways by educational researchers. Gess-Newsome and Lederman, (1999) called PCK an amalgamation or transformation, but not integration, of subject matter, pedagogical and context knowledge. Context knowledge was used in reference to the school and students. According to Van Driel, Verloop and de Vos, (1998), PCK is a construct that is surrounded by the knowledge of the subject matter, general pedagogical knowledge, and contextual knowledge. Oliver and Park (2007) identified five components of PCK as knowledge of students' thinking about science, science curriculum, science-specific instructional strategies, assessment of students' science learning and orientations of teaching science. Beyer and Davis (2011) viewed these components imperative because they work together to help teachers represent specific subject matter in ways that make it comprehensible to students. Boskurt and Kaya (2008) viewed PCK as the knowledge base required for teaching and comprising subject matter knowledge and pedagogical knowledge. They expanded these to show three main components, that is, knowledge of the curriculum, knowledge of learning difficulties of students and knowledge of instructional strategies and activities.

Koehler and Mishra (2006) posited that there are obviously several knowledge systems that are essential to teaching, as well as knowledge of student thinking and learning, and knowledge of subject matter. They identified knowledge of student thinking and learning of Integrated Science, and knowledge of Integrated Science subject matter as components of PCK.

Grossmann (1990) identified four distinct components of PCK: knowledge and beliefs for teaching subject matter; knowledge of students' understanding, conceptions and misconceptions of particular topics in a discipline; knowledge of the curriculum; and knowledge of instructional strategies and representations. In elaborating on these aspects, Magnusson, Krajcik and Borko (1999) conceptualized five criteria for PCK: orientations towards teaching science, knowledge and beliefs of science curriculum, knowledge of students' understanding of science, knowledge of assessment in science and knowledge of instructional strategies.

According to Carlsen (1999), PCK is a form of teacher knowledge and it includes five general knowledge domains: general education context, specific education context, general pedagogical knowledge, subject matter knowledge. It follows therefore that to attain an understanding of Integrated Science and the development of scientific knowledge while taking into consideration the needs of diverse groups of learners, teachers will have to display differentiated and integrated knowledge domains to effectively design and guide learning experiences. This implies that for Integrated Science teachers to be able to teach effectively, they need to have a deep PCK about Integrated Science which will enable them to coordinate all the aspects that influence instruction for effective learning to take place and enhance students' achievement. Teachers need to know how the various disciplines which constitute Integrated Science are interconnected. This knowledge provides a foundation for PCK that enables teachers to make concepts available to students.

Magnusson, Krajcik and Borko (1999) provided five components of the PCK of the science teacher as follows: Orientations toward science teaching, Knowledge about science curriculum, Knowledge about student understanding of science, Knowledge about assessment in science, and Knowledge about instructional strategies for teaching science.

For the purpose of this study the researcher adapted four of them for measuring teachers' PCK in Integrated Science as follows:

1. Knowledge about Integrated Science curriculum,
2. Knowledge about student understanding of Integrated Science,
3. Knowledge about assessment in Integrated Science, and
4. Knowledge about instructional strategies for teaching Integrated Science.

2.3.2.1 Knowledge about Integrated Science curriculum.

This refers to Integrated Science teachers' knowledge about curriculum materials available for teaching Integrated Science as well as about both the horizontal and vertical curricula for Integrated Science (Grossman 1990). This component is indicative of teachers understanding of the importance of topics relative to the Integrated Science curriculum as a whole. This knowledge enables teachers to identify core concepts, modify activities, etc. According to Oliver and Park (2008), PCK for effective teaching is the integration of all aspects of an Integrated Science teachers' knowledge [knowledge about science curriculum, knowledge about student understanding of science, knowledge about assessment in science and knowledge about instructional strategies for teaching science] in highly complex ways. Thus, lack of coherence among the components would be problematic within an individual's developing PCK, and increased knowledge of a single component may not be sufficient to stimulate change in practice.

2.3.2.2 Knowledge about students' understanding of Integrated Science.

This component comprises two categories: The teachers' knowledge about the requirements for learning and knowledge about areas of student difficulty. In this category, the knowledge that students might have different abilities and or learning styles is also included. Teachers should be alert about students' varying abilities and react favourably in order to be effective. Knowledge about areas of student difficulty involves the knowledge about the parts of the topics that students have difficulty in learning. Knowledge of students' perceptions is perceived as one of the essential constituents of teacher knowledge, because, according to Fennema and Franke (1992), learning is based on what happens in the classroom, and thus, not only what students do, but also the learning environment is important for learning. A research carried out by Halim, Mansor and Osman (2011) on the impact of science teachers' PCK on students' conceptual understanding of cellular respiration showed that teacher PCK has positive influence on conceptual understanding of cellular respiration.

2.3.2.3 Knowledge about assessment in Integrated Science.

This element also comprises two categories: The teachers' knowledge about the Integrated Science learning that is important to be assessed in a specific unit and knowledge about the assessment methods (Magnusson et al. 1999). In the first category, Integrated Science teachers should be aware of the aspects of scientific literacy to be able to assess students' conceptual understanding, interdisciplinary ideas, and scientific reasoning and investigation in a specific unit (Champagne, 1989). The second category includes the teachers' knowledge about assessment tools that can be used to assess the important dimensions of students' Integrated Science learning along with knowledge about the advantages and disadvantages of using these tools in a specific unit. A research by Abell (2007) revealed that science teachers' lack knowledge of crucial PCK including lack knowledge of students' science conceptions, knowledge of assessment. This limitation, according to the researcher, might possibly serve as a limiting factor for improved teaching and learning practices.

2.3.2.4 Knowledge about instructional strategies for teaching Integrated Science.

JHS Integrated Science teachers are important participants of Integrated Science teaching process. Not only do JHS Integrated Science teachers need subject matter knowledge for specific topics that are covered in Integrated Science classroom, but also they need to know about effective teaching and learning strategies to transform this knowledge to students. To be able to transform knowledge to students, Integrated Science teachers need to know students' naïve ideas about scientific phenomenon. A Research finding from Halim and Meerah (2002) on Malaysian Trainee Integrated Science teachers' PCK in selected physics concepts in the Integrated Science curriculum revealed that the teachers' PCK for promoting conceptual understanding was limited. According to the researchers the teachers were unable to employ the appropriate teaching strategies required to explain the scientific ideas. This means that the teachers lacked the knowledge required to be able to transform their understanding of basic concepts and present them for students to comprehend.

2.4 The Place of PCK in Science Education

According to Appleton (2006) it is important to understand how science teachers organize and conceptualize their teaching in order to enhance student understanding of the concepts being taught. PCK has been an essential issue for science education researchers for some years now (Dana & Friedrichsen, 2005). Berry, Loughran and Mulhall (2012) explained that effective science teaching is more likely if the teacher is not only knowledgeable about common student alternative conceptions/misconceptions, but draws on this knowledge to shape teaching. In so doing, effective teachers monitor students' understanding in ways that allow them to be responsive to students' learning and create opportunities that help them to more fully grasp the concepts under consideration. Apparently, this cannot be realized by just telling students what they should think and why. Discovering ways of influencing the understandings that they construct and challenging students' alternative conceptions is at the heart of effective teaching. Therefore, as opposed to telling, it is crucial that teachers create meaningful and engaging activities, practices and discussion between students and/or between teacher and student(s) about science ideas and the ways these differ from everyday understandings (Berry, Loughran & Mulhall, 2012). PCK is the knowledge base that enables science teachers to do these effectively. For some years now a significant number of research has emphasized the impact of PCK on science teaching and learning, e.g. Abell, Rogers, Hanuscin, Lee and Gagnon, 2009 (as cited in Karışan, Şenay, & Ubuz, 2013).

2.5 Influence of Teachers' PCK on Their Teaching

Teachers' PCK at all levels of education is one of the most important factors that affect the teaching process. Central questions in literature emphasize how teachers manage their classrooms, organize learning activities, use time and turns, give assignments, decide which levels of questions they ask, plan lessons, and assess general student understanding (Shulman, 1986). Effective teachers do not attempt to transform content knowledge in a rigid manner but do attempt to investigate what the students already know, recognize students' alternative conceptions, and organize a proper educational setting for different academic success levels of students. Shulman (1986) believed that good pedagogical processes must involve presenting the learners with enabling learning situations. These situations in which learners experience the broadest sense of the term include, trying things out to see what happens, manipulating symbols, posing questions and seeking their own answers. A good integrated science teacher needs to help the students to develop the spirit of enquiry through various simulative teaching and learning materials.

A research carried out by Halim and Meerah (2002) on Malaysian Trainee Integrated Science teachers' PCK in selected physics concepts in the Integrated Science curriculum showed that the teachers' PCK for promoting conceptual understanding was limited. This means that the teachers lacked the knowledge required to be able to transform their understanding of basic concepts and present them for students to understand. According to the researchers the teachers' level of content knowledge, however, helped them to be aware of students' possible misconceptions. On the other hand, the teachers were unable to employ the appropriate teaching strategies required to explain the scientific ideas.

Integrated Science teachers therefore need deep PCK to be able to present concepts well to students' understanding and achievement. Chick (2007) believes teacher education and professional development must be more explicit about associated example use. This, according to her will help with what Ball, Hill and Rowan (2005) described as the "inability of many teachers to hear students' flexibility, represent ideas in multiple ways, connect content to contexts effectively, and think about things in ways other than their own" (p.86). Koehler and Mishra (2006), said that "a teacher with deep pedagogical knowledge understands how students construct knowledge, acquire skills, and develop habits of mind and positive dispositions toward learning" (p.15). This implies that teachers with highly developed PCK for specific topics have mastery over subject matter to detect students' misconceptions, know by experience how students' learn, have good knowledge of pedagogy and therefore are able to integrate all these to present concepts effectively to students' understanding.

The foundation of Integrated Science teachers' PCK is thought to be the amalgam of the teachers' pedagogy and Integrated Science content such that it influences their teaching in ways that will best facilitate students' integrated science learning for understanding and achievement (Jang, 2011). PCK influences Integrated Science teachers' teaching by helping them to see how ideas connect across fields and to everyday life. This helps Integrated Science teachers to be able to present the subject matter deeply and flexibly in such a way that it aids students to create useful cognitive maps and relate one idea to another (Shulman, 1987).

PCK assists teachers to create cognitively motivating teaching situations and support learning processes (Kunter et al., 2010). For example, Halim, Mansor and Osman (2011) studied the impact of science teachers' PCK on students' conceptual understanding of cellular respiration and found that teacher PCK has positive influence on conceptual understanding of cellular respiration by students. Abell (2007) posited that science teachers' lack crucial PCK including lack of knowledge of students' science conceptions and knowledge of assessment. This limitation might possibly serve as a limiting factor for improved teaching and learning practices. Furthermore, given the integrated nature of PCK, deficiency in one component of PCK can have significant outcomes for enactment of science teachers' PCK. For instance, knowledge of assessment strategies forms an important component of science teachers' PCK and provides critical feedback to teachers about the effectiveness of their teaching practices and students' achievement. Deficiency in teachers' knowledge of assessment may affect their assessment practices or procedures and students achievement as well.

2.6 Impact of Teachers' PCK on Students' Achievement.

Teachers are the most important aspect of every educational system (Boyd, Landford, Loeb, Rockoff & Wyckoff, 2008). Aaronson, Barrow & Sander (2007) and posited that teachers can considerably influence students' achievement. Eggen, Kauchak and Garry, 2001 (as cited by Adediwura & Tayo, 2007) emphasized that where PCK is lacking, "teachers commonly paraphrase information in learners' textbooks or provide abstract explanations that are not meaningful to their students" (p. 2). Ehindero 1990 (as cited Adedoyin, 2011) confirmed that teacher's teaching is influenced by the level of the acquired PCK of subject matter. Teachers' total control of subject matter and correct use of the subject matter in the process of teaching and learning will always show their level of PCK of the subject matter.

> "The most essential factor in determining the result of the learning process from the teaching strategy is how far the strategy used could assist students in a meaningful lesson. Hence, the most important question is not just how much a teacher can know about knowledge but how a teacher uses what he knows to perform the teaching task for effective learning outcomes" Ball et al, 2001 (as cited in Yusof & Zakaria, 2010). (p.1).

According to Adewuyi, Alabi and Okemakinde (2013), teachers play a crucial role if one wants to effectively prepare students to be able to play their roles in the society to achieve the national set objectives. This role in the researchers view is very important, but how this role is effectively carried out to help students comprehensively know their roles in the society to achieve national development should be emphasized. The quality of every educational system rests to an extent on the quality of teachers in terms of qualification, experience, competency and the level of dedication to their primary functions (Oluremi, 2013) which are all embedded in

PCK. The quality of an educational system can also be assessed based on the achievement of students which is greatly influenced by teachers' PCK. Plasma and Schneider (2011) stated that the success of any teaching and learning process that influences students' academic performance rest on the effectiveness and efficiency of the teachers. Teachers are the facilitators who guide students through the concepts expected to be learnt (Adeyemo, Akintoye & Owolabi, 2011). This then will enhance the realisation of the aims of the subject and student achievement as well. Studies have shown that teachers have a profound effect on student learning, Hanushek, Kain & Rivkin, 2005; Hedges, Konstantopoulos & Nye, 2004; Horn, Sanders & Wright, 1997 (as cited in Huang, Lee, Schroeder, Scott & Tolson, 2007). Wright et al. (as cited in Huang, Lee Schroeder, Scott & Tolson, 2007) after multivariate, longitudinal analyses of schools, class sizes, teachers, and other effects, concluded that ''differences in teacher effectiveness were found to be the dominant factor affecting student academic gain'' (p. 66). Feiman-Nemser, 2001 (as cited in Adedoyin, 2011) stated that a knowledgeable and skilful teacher makes the greatest impact on the learning outcomes of the students. To Feiman-Nemser "Teachers need to know many things, including subject matter, learning, students, curriculum and pedagogy" (p.36) which are all embedded in PCK. According to Lan, She & Wilhelm, (2013), teachers' PCK is essential for effective teaching which directly affects students learning outcomes.

Aina and Olanipekun (2014) in their study on involvement of teachers in the outcome of academic performance of students in Nigerian schools posited that students' academic performance without continuous consideration of teachers' participation in the teaching and learning processes may not lead to significant improvement. They therefore concluded that teachers' self-efficacy and PCK are very important for the teachers to be effective and to be able to improve students' academic learning. The impact of teachers' PCK on the achievement of students in Integrated Science is therefore crucial and directly proportional to each other. They again opined that teachers' self-efficacy, PCK and out-of-field teaching were paramount to the success of any teacher because studies indicate their influence on students' academic performance. Since teachers' PCK has a great impact on students' achievement and progress it is imperative to study the PCK of Integrated Science teachers at JHS level in Ghana. This will enable the researcher ascertain whether low performance of JHS graduates in Integrated Science coupled with lack of scientific curiosity, investigative habits and the use scientific concepts and principles to solve problems of real life has something to do with the teachers' PCK.

2.7 Measuring PCK.

Literature indicates that researchers in various disciplines such as Science, English and Mathematics have used different tools to assess teachers' PCK. These methodologies and techniques range from the use of questionnaires (e.g. PCK Reflection Instrument), classroom observation schedules (Eshun, 2014; Geil, Briggs, Harlow & Otero, 2006), Interview, document examination (e.g. end of term examination questions) (Mensah, 2013), multiple-test items, scenarios, concept maps (Budak & Koseoglu, 2008). Others have used oral and written interviews and classroom observations. For example, Ball, Hill, Rowan and Schilling (2004) developed scenarios, for measuring mathematics, science and language teachers' content knowledge in a survey for the Study of Instructional Improvement (SII) Project. Each of the multiple choice questions contained one correct answer and a number of incorrect answers. Open-ended questionnaires, Classroom observations, closed-ended questionnaire were used in combination with interview by Mochon and

Neyera (2009) to measure different aspects of Mathematical Knowledge for Teaching (MKT). Piburn and Sawada (2000) developed and used Reformed Teaching Observation Schedule (RTOP) to measure “reformed” teaching which considered lesson design implementation, content and classroom culture. Mulhall, Berry and Loughran (2003) developed and used the Content Representation (CoRe), an interview of a particular content taught when teaching a topic, and Pedagogical and Professional-experience Repertoires (PaP-eRs) which is an account of practice intended to illuminate aspects of the CoRe in a particular classroom context. Other researchers had adapted and adopted some of these instruments and used them to suit the purposes of their research.

It is clear from literature that the measurement of PCK by researchers depends a lot on how each individual or group of researchers conceptualises PCK and that diverse instruments are available for adaption or adoption for its measurement.

2.8 Conceptual framework for the study

The conceptual framework for this study relates to the Integrative Model which was proposed by Gess-Newsome (1999) and links to the five components of PCK coined by Maagnusson, Borko and Krajcik (1999). These components are as follows: Orientations toward science teaching, Knowledge about science curriculum, Knowledge about student understanding of science, Knowledge about assessment in science, and Knowledge about instructional strategies for teaching science.

The Integrative Model considers PCK as an act of integrating all components that make the teaching and learning process effective. For this study, PCK in Integrated Science is conceptualised as a paradigm which is influenced mainly by four components apart from Content Knowledge (CK): knowledge about Integrated Science curriculum (KIscC), knowledge about student understanding of Integrated

Science (KSUIscT), knowledge about assessment in Integrated Science (KAIsc), and knowledge about instructional strategies for teaching Integrated Science (KISIsc). These four components come together make Pedagogical Content Knowledge (PCK). Integrated Science teachers' general knowledge of the curriculum informs them in their setting of learning experiences to guide students. This then aids the teachers as to which assessment methods to use in assessing students. Again, Integrated Science teachers need subject matter knowledge for specific topics that are covered in Integrated Science classroom, but also they need to know about effective teaching and learning strategies to transform this knowledge for students understanding. All the aforementioned components come to play integratedly in the form known as PCK to make a teaching

and learning situation effective leading to student achievement. This framework is depicted in Figure 1.

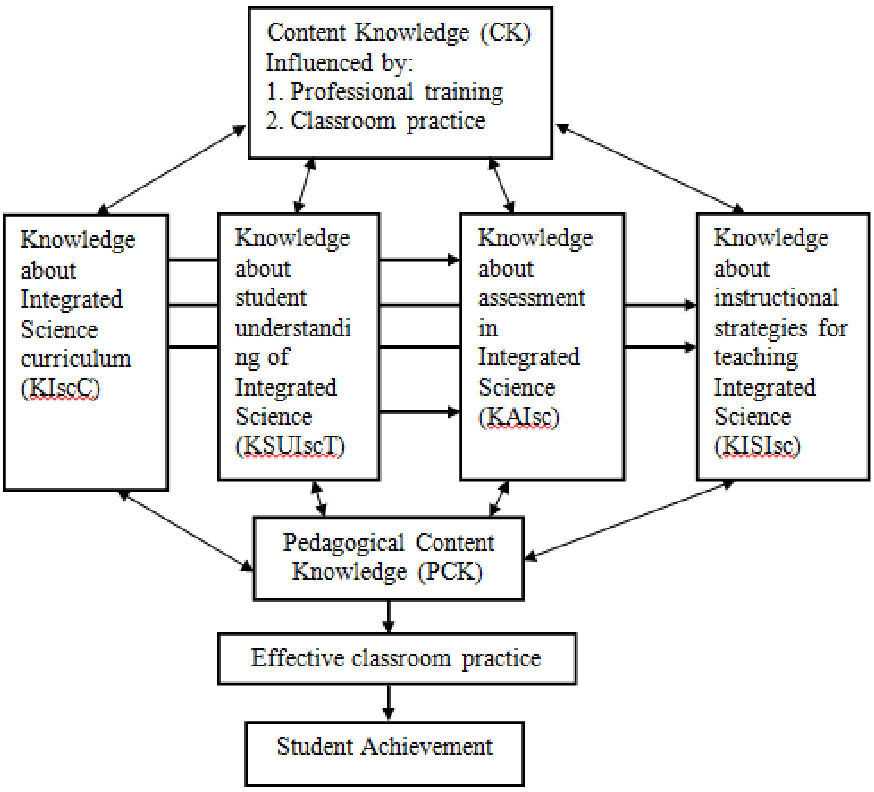

Figure 1: Conceptual framework for the study

2.9 Summary of Literature Review

The literature reviewed in this chapter indicates that educational researchers are particular about what pertains in the classroom. Teaching and learning in general and especially science teaching and learning has been the teacher-centred approach in which students are passive recipients of knowledge from the teacher who is normally considered as the repository of the knowledge. This approach to teaching and learning has been criticized by most educators and educational researchers. Most have recommended that the learner-centred approach to teaching and learning is most appropriate. Teachers' PCK at all levels of education is one of the most important factors that affect the learning process. Quality of education at the basic level leads to improved attitudes among students of science [Integrated Science], higher achievement and increased access (Abell, 2007). Therefore, JHS students need to be taught by teachers who understand science [Integrated Science] content and know how to present it in a way comprehensible to students to aid their achievement in the subject. Lacking such teachers in the classrooms called for a new perspective in teacher education worldwide with a focus of researching into teachers PCK in various disciplines and also helping them to acquire and develop PCK in addition to CK and PK. PCK was first introduced by Shulman (1986 & 1987) as a knowledge that differentiate teachers from subject experts. Other researchers have also proposed similar constructs (e.g. Magnusson, Krajcik & Borko, 1999; Oliver & Park, 2007; Boskurt & Kaya, 2008).

Most educational researchers (e.g. Gess-Newsom & Lederman, 1999; Van Driel, Verloop & de Vos, 1997; Boko & Putnam, 2000; Koehler & Mishra, 2006; Oliver & Park, 2007; Boskurt & Kaya, 2008; Chai, Koh & Tsait, 2010; Koehler, 2011; Bayer & Davis, 2011; Nuangchalerm, 2012; Oliver & Park, 2014) have agreed that there is an existence of another form of knowledge other than CK and PK which is PCK. PCK has been conceptualised in diverse ways by some of these researchers. PCK is an amalgamation or transformation of subject matter, pedagogical and context knowledge (e.g. Gess-Newsom & Lederman, 1999; Koehler, 2011), PCK is the integration of subject matter, general pedagogical knowledge, and contextual knowledge (e.g. Van Driel, Verloop & de Vos, 1997; Nuangchalerm, 2012; Chai, Koh & Tsait, 2010). Teachers PCK has been found to greatly influence their teaching (Halim & Meerah, 2002; Koehler and Mishra, 2008; Abell, 2007; Oliver & Park, 2008). Also, teachers PCK is found to have an impact on students' achievement (Adedoyin, 2011; Lan, She & Wilhelm, 2011; Aina & Alanipekun, 2015).

The measurement of PCK range from the use of questionnaires (PCK Reflection Instrument), classroom observation schedules (Eshun, 2014), questionnaires, Interview, document examination (end of term examination questions) (Mensah, 2013), multiple-test items, scenarios, concept maps (Budak & Koseoglu, 2008), classroom observations (Geil, Briggs, Harlow & Otero, 2006. Content Representation (CoRe) and Pedagogical and Professional-experience Repertoires (PaP-eRs) (Mulhall, Berry & Loughran, 2003)

The review of literature led to the development of a conceptual framework for this study which considered PCK as composed of KSUIs, KIsC, KA and KIS. Each of these components is influenced by a number of factors and they interact with each other. Their effective integration in classroom practice leads to the demonstration of PCK which will also influence students' achievement.

2.10 Organisation of other chapters

Chapter three describes the research procedure and techniques that were employed by the researcher for the study. These include the research design, population, sample and sampling procedure, instruments for data collection, data collection procedure, validity and reliability, and how the data was analysed. Chapter four presents the results of the study and Chapter five discuss the results. Chapter six which is the final chapter presents the summary of the study, conclusions, recommendations and suggestion for further research.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter describes the research procedures and techniques that were employed by the researcher for the study. These include the research design, population, sample and sampling procedure, instruments for data collection, data collection procedure, validity and reliability, and how the data was analysed.

3.1 Research Design

Research design is essentially a plan illustrating the strategy of investigation by the researcher (Cohen, Manion & Morrison, 2007). Yin, 2003 (as cited in Akor, Hamzah, & Rashid, 2015) adds further that "colloquially a research design is an action plan for getting from *here* to *there*, where '*here'* may be defined as the initial set of questions to be answered and '*there'* is some set of (conclusions) answers" (p. 19). In this plan, the kind of data needed, the method used for the data collection, the procedures for obtaining data, and data analysis procedures are clearly outlined. The researcher employed the mixed method research design (i.e. both qualitative and quantitative) for this study.

According to Hantrais (2005), "attempts to make sense of variety have led to a blurring of the traditional methodological divide between quantitative and qualitative paradigms, opening up new perspectives and creating opportunities for synergies and complementarities" (p. 399). The philosophical orientation associated with mixed methods is pragmatist, employing both narrative (qualitative) and numeric (quantitative) approaches to answering research questions (Tashakkori & Teddlie, 2003). Literature indicates that mixed methods provide accurate and increased levels of confidence in research findings, Kellie, 2001 (as cited in Ndlovu, 2014) as well as producing new knowledge by the combination of findings from different research approaches (Foss & Ellefsen, 2002). In addition, when methods are combined, the weaknesses of one method can be enhanced by the strength of the other (Johnson & Onwuegbuzie, 2004).

Azorín and Cameron (2010), classified the mixed method designs basically into four. These are: the convergent parallel design, the explanatory sequential design, the exploratory sequential design, and the embedded design.

The convergent parallel design (convergent design) occurs when the researcher uses concurrent timing to implement the quantitative and qualitative strands during the same phase of the research process, prioritizes the methods equally, and keeps the strands independent during analysis and then mixes the results during the overall interpretation.

The explanatory sequential design (explanatory design) occurs in two distinct interactive phases. This design starts with the collection and analysis of quantitative data, which has the priority for addressing the study's questions. This first phase is followed by the subsequent collection and analysis of qualitative data. The second, qualitative phase of the study is designed so that it follows from the results of the first, quantitative phase. The researcher interprets how the qualitative results help to explain the initial quantitative results. The exploratory sequential design (exploratory design) also uses sequential timing. In contrast to the explanatory design, the exploratory design begins with and prioritizes the collection and analysis of qualitative data in the first phase. Building from the exploratory results, the researcher conducts a second, quantitative phase to test or generalize the initial findings. The researcher then interprets how the quantitative results build on the initial qualitative results. The embedded design occurs when the researcher collects and analyses both quantitative and qualitative data within a traditional quantitative or qualitative design. In an embedded design, the researcher may add a qualitative strand within a quantitative design, such as an experiment, or add a quantitative strand within a qualitative design, such as a case study. In the embedded design, the supplemental strand is added to enhance the overall design in some way.

The explanatory sequential mixed method design was used to explore the PCK of Integrated Science teachers and its perceived impact on students' achievement at the JHS level in the Atebubu-Amantin District in Brong Ahafo Region of Ghana. This is due to the fact that the study was of quantitative priority where greater emphasis was placed on the quantitative method while the qualitative method played a secondary role. Quantitative data was first collected using questionnaire and based on the information gathered from the quantitative data a qualitative data was later collected through classroom observation.

Azorín and Cameron (2010), said that the advantages of the explanatory design makes it the most straightforward of the mixed methods designs. Some of these advantages include the following: Its two-phase structure makes it straightforward to implement, because the researcher conducts the two methods in separate phases and collects only one type of data at a time. This means that a single researcher can use this design; a research team is not required before one can use the design. Also the final report can be written with a quantitative section followed by a qualitative section, making it straightforward to write and providing a clear delineation for readers.

Figure 2 below shows a summary of the design for the study.

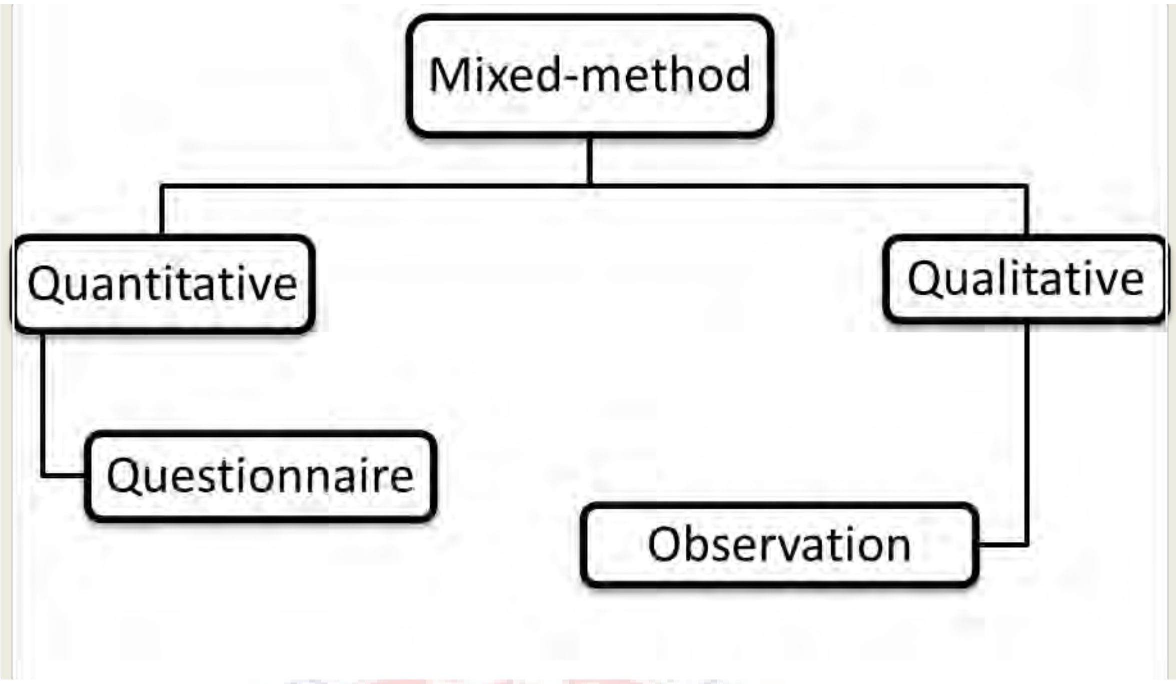

Figure 2 Summary of the design for the study

3.2 Population

The population for this study included all Integrated Science teachers and year three (JHS 3) students in the JHS in the Brong Ahafo Region of Ghana. According to Cohen, Manion and Morrison (2007), a targeted population is a group of respondents from whom the researcher is interested in collecting information and drawing conclusions. Thus, for this study, the target population comprised all professionally trained JHS 3 Integrated Science teachers and JHS three students in Atebubu-Amantin District in the Brong Ahafo Region of Ghana.

3.3 Sample and Sampling Procedure

The sample size for the study was One hundred and forty-three (143) respondents comprising fifteen (15) professionally trained Integrated Science teachers and one hundred and twenty-eight (128) JHS 3 students. Simple random sampling technique was employed by the researcher to select the sample of circuits and schools for the study, after which purposive sampling technique was used to select respondents (both teachers and students) for the study. This is because the study involved only JHS 3 Integrated Science teachers and JHS three students in the Atebubu-Amantin district in the Brong Ahafo Region of Ghana. According to Cohen, et al. (2000), purposive sampling entails one that deliberately selects cases on the basis of the specific qualities they illustrate. Cohen, et al. (2007) proposed that a right sample size is one that fulfils the requirements of the study. The researcher also used simple random sampling technique to select ten (10) of the trained Integrated Science teachers out of the fifteen (15) teachers for classroom observation.

Enrolments and Staffing Statistics of public JHS (2014/2015 academic year) collected from the GES office Human Resource Division in Atebubu showed that Atebubu-Amantin district has six (6) circuits, namely; Amanten North, Amanten South, Atebubu North, Atebubu South, Atebubu East and Atebubu West. A total of thirty-seven (37) public JHS and one thousand six-hundred and ten (1610) JHS 3 students were in the district as at the time the research was conducted. The researcher randomly selected four of the circuits mentioned above. These circuits were Amanten North, Amanten South, Atebubu West and Atebubu South. Random sampling was also used to select two schools each from these four circuits.

Table 1 shows summary of circuits, schools, students and teachers selected.

Table 1

Summary of circuits, schools, students and teachers selected for the study.

Circuits	Schools	JHS 3 students population	30% of JHS 3 population	Number of Integrated Science teachers
Amanten North	A	42	13	2
	B	37	11	1
Amanten South	C	109	33	3
	D	66	20	2
Atebubu East	E	41	12	2
	F	45	14	2
Atebubu South	G	66	20	2
	H	16	5	1
Total		422	128	15

3.4 Instruments for Data Collection

The researcher used Questionnaires and Observation schedule as the main instruments in gathering data for the study. The description of each of the instruments is as follows:

3.4.1 Questionnaires

The close-ended questionnaires were categorised into two groups. The first category as shown in Appendix A was for the teachers and it was divided into two sections A and B. Section A required the Demographic data of the teachers which included five close-ended items s Sex, Age, Highest educational qualification, Institution attended and duration of teaching Integrate Science. Section B was made of sixteen (16) close-ended five-point Likert scale structured questions adapted from Adedoyin (2011).The questions centred on Knowledge about Integrated Science

Curriculum (KIscC), Knowledge about Student Understanding of specific Integrated Science topics (KSUsIscT), Knowledge about Assessment in Integrated Science (KAIsc), and Knowledge about Instructional Strategies for teaching Integrated Science (KISIsc).This questionnaire was administered to fifteen (15) teachers. The second category of questionnaire as shown in Appendix B which was designed for the students was also made up of sections A and B. Section A (Demographic data) consist of two close-ended items as Sex and Age. Section B comprised twenty (20) close-ended five-point Likert scale structured questions adapted from Adedoyin (2011) which also centred on Knowledge about Integrated Science Curriculum (KIscC), Knowledge about Student Understanding of specific Integrated Science topics (KSUsIscT), Knowledge about Assessment in Integrated Science (KAIsc), and Knowledge about Instructional Strategies for teaching Integrated Science (KISIsc).The teachers' questionnaires were geared toward measuring teachers' PCK and how it influences their teaching. The students' questionnaire which was also geared toward students' perception of the impact of teachers' PCK on their achievement in Integrated Science was administered to one hundred and twenty-eight (128) JHS 3 students in the selected schools.

3.4.2 Observation Schedule

A PCK observation schedule adapted from Park & Oliver (2008) was also designed in line with the items on the teachers' questionnaire to help the researcher to confirm the responses given by the teachers in the questionnaire during observations of their classroom practice. The four components of the schedule were rated on a four-point scale, from "limited" (1) to "exemplary" (4). The questions in each component were scored singly as an item, so that the test comprised four items each with a mark score of four. A set of criteria for each component was indicated. A copy of this schedule is shown in Appendix C.

3.5 Validity and Reliability

Validity and reliability are issues that have been of great concern in most educational and science research. The terms validity and reliability are used to establish the quality of research instruments. For any instrument to be considered useful, it should produce data that is trustworthy and meaningful so that the results obtained could be generalized in other settings (Creswell, 2005). This implies that instruments used to conduct a study should undergo validation to check their authenticity. Validation therefore is a process of assessing authenticity and dependability (Creswell, 2005) of the means used to collect data. In a case where one instrument is used, validation helps ascertain whether the instrument measures what it is intended to measure. To enhance the validity of this study, the researcher face validated the instruments by discussing the questionnaires and the PCK observation guide adapted from Park and Oliver (2008) with some of the lecturers of the Department of Science Education in the first place. They checked whether each item in the questionnaires was related to what it was supposed to measure. They also checked whether the questions were relevant, precise, worded properly and if there was any ambiguity in questions so that test items could be interpreted correctly by respondents. Again, they checked if questions in the questionnaires were in alignment with the four knowledge components of the PCK which were adapted from Grossman (1990). The researcher then handed them over to his supervisor for further scrutiny. After this, the Cronbach alpha (α) values of both teachers' and students' questionnaires were found to be 0.72 and 0.68 respectively (see Appendices D and E) to ascertain their reliability. Alpha values of approximately 0.7 are considered reliable (Kline, 2005 and Cohen, Manion & Morrison, 2007). To further enhance the validity of the study, the researcher used both qualitative and quantitative approaches to collect the data. Within the qualitative section, he conducted observations, and in quantitative section, he administered questionnaire. In addition, he collected the data from diverse sources (i.e. Teachers, students and observation schedule. The reason he used diverse sources was because he wanted to draw his findings based on a rich source of data. Maxwell (2005) and Rossman (2003) support the idea that by triangulation a researcher can reduce the weakness that come with using one source.

3.6 Data Collection Procedure

Prior to the data collection a permission letter was acquired from the District Director of Education, Atebubu and attached to an Introductory Letter (Appendix J) from the Department of Science Education, UEW. These were presented to the Head teachers of the selected schools for permission to carry out the study and the purpose of the study explained to them. In all the selected schools the Head teachers gave the researcher an opportunity to have a chat with the Integrated Science teachers as well as the JHS 3 students. Data collection was done through the administration of questionnaire and classroom observation of teachers in selected schools. The procedure for administration of each instrument is described as follows:

3.6.1 Questionnaire

The researcher administered twenty-one (21) fixed response questions to fifteen (15) Integrated Science teachers and twenty-two (22) fixed response questions also to one hundred and twenty-eight (128) JHS 3 students in the schools that were selected for the study. The researcher calculated 30% of the total JHS 3 population of each of the selected schools to arrive at the 128. This was done so as to get an exact representation of JHS 3 students for every school. All the 15 Integrated Science teachers in the eight schools selected from the four circuits were administered with questionnaire. The researcher administered the questionnaire alone. He spent one day in administering the questionnaire in each of the four circuits. A total of 128 students questionnaire were administered. Out of this, 124 were returned representing 96.9% return rate. The return rate for the teachers' questionnaire administered to the 15 teachers was 100%.

3.6.2 Observation Schedule

Ten (10) out of the fifteen (15) trained Integrated Science teachers who responded to the questionnaire were selected at random for the observation. These teachers were pre-informed about the selection through phone calls. All of them agreed to be observed during their classroom teaching. The entire observation period lasted ten days. During the observation day for each of them the researcher went to their prospective schools and sat in their classrooms during Integrated Science lessons for observation. In most cases students became curious about my presence but the teachers told them not to be alarmed because I was there to help the lesson to run smoothly. The teachers were observed and scored using the PCK rubric (observation schedule) adapted from Park and Oliver (2008) as shown in Appendix C. This observation data was used to cross check the responses provided by the teachers in the questionnaire. Since the research was about the general PCK of Integrated Science teachers, they were observed on any topic that the researcher went and found them teaching. Some of the topics teachers were observed on are: Acids and bases, force and pressure, machines, Soil and water conservation and food and nutrition.

3.7 Data Analysis

The quantitative data entry and analysis was done by using the Statistical Package for Social Sciences (SPSS) software version 22. Descriptive statistics (means, standard deviation and frequencies) and percentages were used to analyse the respondents' responses to the questionnaire after they had been coded. The analysed data were presented in tables as means and percentages.

CHAPTER FOUR

PRESENTATION OF RESULTS

4.0 Overview

This chapter presents the analysis of the data collected from respondents (Integrated Science teachers and JHS 3 students). Questionnaire and observation checklist were designed to collect data for the following research questions:

1. What is the PCK level of Junior High School Integrated Science teachers' in the Atebubu-Amantin District?
2. How does the Integrated Science teachers' PCK influence their teaching?
3. How do students perceive the impact of Integrated Science teachers' PCK on their achievements in Integrated Science?

The data were analysed into frequencies, percentages, means and standard deviations. These are presented in tabular form.

4.1 Demographic Characteristics of Respondents (Teachers)

This section presents the analyses of teachers' sex, age, highest qualification, the kind of institution they obtained their highest qualification from and years of teaching experience in Integrated Science. They are drawn from items 1-5 of the teachers' questionnaire.

4.1.1 Sex of respondents (teachers)

Table 2 indicates the distribution of respondents by sex.

Table 2

Sex of respondents (teachers)

Sex	Frequency	Percentage
Male	13	86.7
Female	2	13.3
Total	15	100.0

Results in Table 2 show that 13(86.7%) of the respondents were males, while the remaining 2(13.3%) were females. The reason is that few females teach Integrated Science at the JHS level in the Atebubu-Amantin district.

4.1.2 Respondents' Age range

The age range of respondents is shown in Table 3

Table 3

Age range of respondents (teachers).

Age range	Frequency	Percentage
19-25 years	7	46.6
26-30 years	4	26.7
31-35 years	4	26.7
Total	15	100.0

From Table 3, out of the fifteen (15) teachers used for the study, 7(46.6%) were aged between 19 and 25 years; 4(26.7%) between 26 and 30 years. The remaining 4(26.7%) were within the range 31-35 years. This indicates that the majority of the teachers were aged between 19 and 25 years. However, it could be said that about 50% of teachers were aged between 19 and 25 years while 50% were also aged between 26 and 35 years.

4.1.3 Educational qualification of respondents

Table 5 indicates the distribution of respondents by their highest educational qualification.

Table 4

Educational qualification

Certificate	Frequency	Percentage
Master's degree	1	6.7
First degree	1	6.7
Diploma	13	86.6
Total	15	100.0

From the results in table 4, 13(86.6%) of the respondents had diploma, one (1) representing 6.7% had first degree. The remaining one (1) representing 6.7% had master's degree. This indicates that the respondents who were teaching with diploma out-numbered the total number of respondents with first degree and master's degree.

4.1.4 Kind of institution respondents attended for highest qualification

The kind of institutions respondents attended for highest educational qualification is shown in Table 5.

Table 5

The Kind of Institution Attended

Kind of institution	Frequency	Percentage
University	2	13.3
College of Education	13	86.7
Total	15	100.0

Results in Table 5 show that out of the fifteen (15) respondents (teachers) used for the study, 13(86.7%) were College of Education graduates and the remaining 2(13.3%)

were university graduates. This means that at JHS level in the Atebubu-Amantin district, the highest qualification of most of the teachers is diploma.

4.1.5 Respondents' years of teaching experience in Integrated Science

The respondents' years of teaching experience in Integrated Science was considered in Table 6.

Table 6

Experience in teaching Integrated Science

Years	Frequency	Percentage
1-5 years	11	73.3
6-10 years	2	13.3
11 years and above	2	13.3
Total	15	100.0

From Table 6 above, out of the fifteen (15) teachers, 11 representing (73.3%) had taught between 1-5 years, 2 representing (13.3%) had taught between 6-10 years. The remaining 2 also representing (13.3%) had taught for 11 years and above. This indicates that most of the teachers are in the early years of their teaching career while a few (4) were in the stable years of their teaching career. According to Ubuz and Yayan, 2010 (as cited in Karışan, Şenay &Ubuz, 2013) experience in teaching become stable after around five years.

4.2 Demographic Characteristics of Students

This section presents the Students' Sex and Age. This was necessary because the researcher wanted to find out whether there is a relationship between Students' Sex, Age and their perception of their teachers' PCK on their academic achievement in Integrated Science.

4.2.1 Sex of students

Table 7 shows the sex of the JHS 3 students used in this study.

Table 7

Sex of Students

Sex	Frequency	Percentage
Male	64	51.6
Female	60	48.4
Total	124	100.0

Results in Table 7 show that, out of the one hundred and twenty-four (124) students used for the study, 64 (51.6%) were males while the remaining 60 (48.4%) were females. This indicates that the number of male respondents were slightly above the female respondents.

4.2.2 Age range of the JHS 3 Students used in this study

The age ranges of students are shown in Table 8.

Table 8

Age range of Students

Age range	Frequency	Percentage
12-13 years	1	0.8
14-15 years	53	42.7
16-17 years	58	46.8
18 and above	12	9.7
Total	124	100.0

From the results in Table 8, 58(46.8%), 53(42.7%), 12(9.7%), 1(0.8%) fell within the age ranges 16-17, 14-45, 18 and above, and 12-13 years respectively. Thus, majority (111) of the students involved in the study were within the age range of14-17 years while a few were within the age range of 18 and above years. Only one (1) student was between 12 and 13 years.

4.3. Data Collected on Research Questions

In this section the main data collected for answering the research questions are presented. The questionnaire and observation schedule are presented together to address research questions one and two. The research questions were addressed using the responses from the questionnaire. The observation schedule was used to confirm the responses given in the questionnaire. This helped the researcher to triangulate the results.

4.3.1 Research Question One: What is the PCK level of Junior High School Integrated Science teachers' in the Atebubu-Amantin District?

This question sought to find out the PCK of the teachers in teaching Integrated Science. This question was answered under these four PCK components: Knowledge of Integrated Science Curriculum (KIsC), Knowledge of Students Understanding of Integrated Science (KSUIs), Knowledge about Instructional Strategies for Teaching Integrated Science (KIS) and Knowledge about Assessment in Integrated Science (KA).

4.3.1.1 Knowledge of Integrated Science Curriculum (KIsC)

This component sought to find out the knowledge of the Integrated Science teachers regarding the Integrated Science Curriculum they use in teaching. Items 7, 14, 18 and 20 of the teachers' questionnaire (see Appendix A) were used to solicit responses from the teachers on the knowledge of Integrated Science Curriculum. The second PCK component of the observation checklist (see Appendix C) was also used to find teachers knowledge of the Integrated Science Curriculum.

Table 9 (a) shows analysis of teachers' responses to their knowledge of the Integrated Science Curriculum. Respondents gave various responses to the items.

Table 9(a)

Teachers' Knowledge of Integrated Science Curriculum.

No.	Statements	N	Mean	Std. Deviation
7	Integrated Science is concerned about curiosity, creativity in solving problems and critical thinking.	15	4.13	0.990
14	The Integrated Science curriculum is based on the Spiral Approach.	15	3.20	1.082
18	Integrated Science does not recognise the vulnerability of the natural environment.	15	2.93	0.961
20	Integrated Science is not necessarily the holistic study of the science disciplines.	15	2.53	1.060

Results in Table 9 (a) show that the Integrated Science Teachers sampled for the study agreed that Integrated Science is concerned about curiosity, creativity in solving problems and critical thinking (M=4.13, SD=0.990). The teachers also respectively agreed that Integrated Science recognises the vulnerability of the natural environment and also that Integrated Science is the holistic study of the various science disciplines (M=2.93, SD=0.961) and (M=2.53, SD=1.060). On the other hand, the teachers were somehow neutral to The Integrated Science curriculum is based on the Spiral Approach (M=3.20, SD=1.082).

Table 9(b)

Observation items on Teachers Knowledge of Integrated Science Curriculum

PCK component	Statements	Levels			
		L(1)	B(2)	P(3)	E(4)
Knowledge of Integrated Science Curriculum	Attempt to encourage creativity and critical thinking through activities and questioning.	1	3	6	-
	Attempt to integrate concepts to make the subject holistic to students.	2	1	3	4
	Understanding of the application of concepts in everyday life.	4	3	3	-
	Understanding of the curriculum as spiral.	7	2	1	-

Where L=Limited, B=Basic, P=Proficient, E=Exemplary

The results in Table 9 (b) show that out of the ten (10) teachers observed, 1(10%), 3(30%), 6(60%) of them showed limited, basic and proficient knowledge in attempting to encourage creativity and critical thinking through activities and questioning. Also, 2(20%), 1(10%), 3(30%), 4(40%) showed limited, basic, proficient and exemplary knowledge in attempting to integrate concepts to make the subject holistic to students respectively. Again, 4(40%) had limited, 3(30%) had basic and 3(30%) had proficient knowledge in understanding the application of Integrated Science concepts in everyday life. Furthermore, 7(70%), 2(20%) and 1(10%) showed limited, basic and proficient knowledge in understanding the Integrated Science curriculum as spiral.

4.3.1.2 Knowledge of Students' Understanding of Integrated Science (KSUIs)

This component sought to find out the knowledge of the Integrated Science teachers regarding the Students Understanding of Integrated Science. Items 6, 12, 17 and 21 of the teachers' questionnaire (see Appendix A) were used to solicit responses from the teachers on the knowledge of Students Understanding of Integrated Science. The first PCK component of the observation checklist (see Appendix B was also used to find teachers knowledge of students understanding of Integrated Science.

Table 10 (a) shows analysis of teachers' responses to their knowledge of students understanding of Integrated Science.

Table 10(a)

Teachers Knowledge of Students Understanding of Integrated Science (KSUIs)

No.	Statements	N	Mean	Std. Deviation
6	It is not necessary for the teacher to be aware of the topics difficult for students in Integrated Science.	15	3.33	1.759
12	Students' misconceptions should be overlooked by teachers to enable systematic presentation of a lesson.	15	3.93	1.280
17	Teacher knowing students' prior knowledge and connecting it to new knowledge is an effective way of teaching.	15	4.07	0.961
21	Teacher should pose questions to correct students' misconceptions.	15	4.33	0.488

The results in Table 10 (a) show that the teachers agreed that teacher knowing students' prior knowledge and connecting it to new knowledge is an effective way of teaching (M=4.07, SD=0.961) and that teacher should pose questions to correct students' misconceptions (M=4.33, SD=0.488). In contrast, the teachers disagreed that Students' misconceptions should be overlooked by teachers to enable systematic presentation of a lesson (M=3.93, SD=1.280). The teachers agreed that it is not necessary for the teacher to be aware of the topics difficult for students in Integrated Science (M=3.33, SD=1.759).

Table 10 (b)

Observation items on Teachers Knowledge of Students Understanding of Integrated Science.

PCK component	**Statements**	**Levels**			
		L(1)	B(2)	P(3)	E(4)
Knowledge of Students Understanding of Integrated Science (KSUIs)	Overlooking students' misconceptions.	6	3	1	-
	Understanding of students' common learning difficulties.	3	5	2	-
	Knowing students' prior knowledge and connecting it to new knowledge.	2	-	5	3
	Posing questions to correct students' misconceptions.	4	4	1	1

The results in Table 10 (b) show that out of the ten (10) teachers observed, 5(50%), 3(30%), 2(20%) of them had exemplary, proficient and limited knowledge respectively in students' prior knowledge and connecting it to new knowledge. Also, 4(40%), 3(30%), 2(10%) and 1(10%) respectively showed limited, basic, proficient and exemplary knowledge in posing questions to correct students' misconceptions. Again, 6(60%) had limited, 3(30%) had basic and 1(10%) had proficient knowledge in overlooking students' misconceptions.

4.3.1.3 Teachers Knowledge about Instructional Strategies for Teaching Integrated Science (KIS)

This component sought to find out the knowledge of the Integrated Science teachers regarding the Instructional Strategies for Teaching Integrated Science. Items 9, 11, 15 and 19 of the teachers' questionnaire (see Appendix A) were used to solicit responses from the teachers on this issue. The fourth PCK component of the observation checklist (see Appendix B) was also used to find out teachers' knowledge on Instructional Strategies for Teaching Integrated Science.

Table 11 (a) shows analysis of teachers' responses to their knowledge of Instructional Strategies for Teaching Integrated Science.

Table 11(a)

Teachers Knowledge about Instructional Strategies for Teaching Integrated Science (KIS)

No.	Statements	N	Mean	Std. Deviation
9	I use different ways/methods to develop students understanding of Integrated Science.	15	4.20	1.207
11	Teacher adapting to variations in ability and background of students' does not affect the lesson.	15	2.47	1.356
15	Involving students in the lesson fully delays the lesson.	15	4.13	0.990
19	The teacher should teach most of the time using the student centred-method.	15	3.27	1.335

The result in Table 11 (a) indicates that the teachers use different ways/methods to develop students' understanding of Integrated Science (M=4.2, SD=1.207). The teachers agreed that teacher adapting to variations in ability and background of students affect the lesson (M=2.47, SD=1.356). Also, the teachers agreed with the statement that involving students in the lesson fully delays the lesson (M=4.13, SD=0.990). On the other hand, the teachers were somehow neutral to the statement that the teacher should teach most of the time using the student-centred method (M=3.27, SD=1.335).

Table 11(b)

Teachers Knowledge about Instructional Strategies for Teaching Integrated Science (KIS).

PCK component	**Statements**	**Levels**			
		L(1)	B(2)	P(3)	E(4)
Knowledge of Instructional Strategies (KIS)	Use different methods to develop students understanding of Integrated Science.	-	2	3	5
	Adapting to variations in ability and background of students.	7	2	1	-
	Involving students in the lesson.	4	5	1	-

The results in Table 11 (b) show that 5(50%), 3(30%), 2(20%) of the teachers had exemplary, proficient, and basic knowledge respectively in the use of different methods to develop students understanding of Integrated Science. Also, 7(70%), 2(20%), 1(10%) of the teacher observed showed limited, basic and proficient knowledge respectively in adapting to variations in ability and background of students. Again, 4(40%) showed limited, 5(50%) showed basic and 1(10%) showed proficient knowledge in involving students in the lesson.

4.3.1.4 Teachers Knowledge about Assessment in Integrated Science (KA).

This component sought to find out the knowledge of the Integrated Science teachers regarding Assessment in Integrated Science. Items 8, 10, 16 and 20 of the teachers' questionnaire (see Appendix A) were used to solicit responses from the teachers on Assessment in Integrated Science. The third PCK component of the observation checklist (see Appendix B was also used to find teachers' knowledge of Assessment in Integrated Science.

Table 12 (a) shows analysis of teachers' responses to their knowledge of Assessment in Integrated Science.

Table 12(a)

Teachers Knowledge about Assessment in Integrated Science (KA).

No.	Statements	N	Mean	Std. Deviation
8	Summative assessment is the only way to test students understanding of Integrated Science.	15	2.40	1.056
10	The teacher has to ask students questions for proper understanding in the classroom.	15	3.93	0.961
13	Teacher providing hands-on activities for students to learn Integrated Science wastes time.	15	4.20	0.775
16	The teacher should give all students in the classroom a chance to answer questions.	15	2.67	1.633

The result in Table 12 (a) show that the teachers disagreed with the statement that summative assessment is the only way to test students' understanding of Integrated Science (M=2.40, SD=1.056). Also the teachers' agreed that the teacher has to ask students questions for proper understanding in the classroom (M=3.93, SD=0.961). The teachers agreed that teacher providing hands-on activities for students to learn

Integrated Science waste time (M=4.20, SD=0.775). Again, the teachers disagreed with the statement that the teacher should give all students in the classroom a chance to answer questions (M=2.67, SD=1.633).

Table 12(b)

Teachers Knowledge about Assessment in Integrated Science (KA)

PCK component	Statements	Levels			
		L(1)	B(2)	P(3)	E(4)
Knowledge of Assessment	Questions to probe student understanding.	3	3	4	-
	Provides hands-on activities for students.	6	4	1	-
	Gives all students in the classroom chance to answer questions.	4	4	1	1

The results in Table 12 (b) show that out of the ten (10) teachers observed, 3(30%) showed limited, 3(30%) showed basic, 4(40%) of them showed proficient knowledge in asking questions to probe students' understanding in the classroom. Also, 6(60%), 4(40%), 1(10%) showed limited, basic, proficient knowledge respectively in providing hands-on activities for the students to learn Integrated Science. Again, 4(40%) showed limited, 4(40%) showed basic, 1(10%) showed proficient and 1(10%) showed exemplary knowledge in giving all students in the classroom the chance to answer questions.

4.3.2: Research Question Two: How does the teachers' Integrated Science PCK influence their teaching?

This question sought to find out how the PCK of the teachers influenced their teaching of Integrated Science. Items 6, 8, 10, 11, 12, 13, 15, 16, 17, 19 and 21 of the teachers' questionnaire (see Appendix A) were used to answer this question.

The results from Table 13 (see Appendix F) indicate that teachers agreed that teacher providing hands-on activities for students to learn Integrated Science waste time (M=4.20, SD=0.775), involving students in the lesson fully delays the lesson (M=4.13, SD=0.990), teacher knowing students' prior knowledge and connecting it to new knowledge is an effective way of teaching (M=4.07, SD=0.961), teacher should pose questions to correct students' misconceptions (M=4.33, SD=0.488). Also, teachers agreed that the teacher has to ask students questions for proper understanding in the classroom (M=3.93, SD=0.961), students' misconceptions should be overlooked by teachers to enable systematic presentation of a lesson (M=3.93, SD=1.280). Again, teachers were neutral that it is not necessary for the teacher to be aware of the topics difficult for students in Integrated Science (M=3.33, SD=1.759), the teacher should teach most of the time using the student centred method (M=3.27, SD=1.335). On the other hand, teachers disagreed that summative assessment is the only way to test students understanding (M=2.40, SD=1.056), teacher adapting to variations in ability and background of students does not affect the lesson (M=2.47, SD=1.356), the teacher should give all students in the classroom chance to answer questions (M=2.67, SD=1.633).

4.3.3 Research Question Three: How do students perceive the impact of teachers' Integrated Science PCK on their achievements in Integrated Science?

This question sought to find out the perception of students about the impact of teachers' PCK on their achievement in Integrated Science. Items 4 to 23 on the students' questionnaire (see Appendix B) were used to solicit responses from students to answer this question.

Appendix G is the sample statistics of students' responses to the 20 items of the questionnaire, with the mean responses ranging from 4.12 to 2.10. Also results in Appendix H show that, out of the twenty items on Integrated Science teachers' PCK, fifteen (15) items were perceived to be significant at 0.05 alpha level by JHS students in relation to their achievements in Integrated Science. Appendix I specifies the order in terms of ranking of means from the largest mean value to the lowest mean value. These were used to determine the most and least perceived teachers' PCK that have significant effect on JHS students' achievements in Integrated Science. From the results in Appendices G, H and I, it can be concluded that JHS students perceived that Integrated Science teachers' PCK has significant effect on their achievements in Integrated Science. The findings indicated that JHS students perceived that Integrated Science teachers' PCK has an impact on their academic performance in the following areas: motivating students to learn Integrated Science, teacher exhibiting good knowledge of Integrated Science, encouraging all students to participate in all classroom discussions, using charts, diagrams, models, illustrations to show Integrated Science ideas (concepts), knowing the previous knowledge of students and connecting it to new knowledge, aware of the topics that are difficult for students in the classroom, encouraging students to think logically in solving problems, posing questions to correct students' misconceptions and allowing students to fully participate in lessons.

CHAPTER FIVE

DISCUSSION

5.0 Overview

This chapter discusses the findings of the study according to the research questions.

5.1 PCK level of Junior High School Integrated Science teachers' in the Atebubu-Amantin District

The results on teachers' knowledge of Integrated Science curriculum (syllabus) showed that the teachers were familiar with the Integrated Science curriculum (syllabus) they used in teaching the students. Notwithstanding the fact that the teachers were familiar with the curriculum, they lacked knowledge of a major aspect of the curriculum, which is its spiral nature. According to Ball, Hill & Schilling (2004), knowledge of curriculum involves awareness of how topics are arranged both within a school year and over time and ways of using curriculum resources, such as textbooks, to organise a program of study for students. Their responses to the question and the observation check list on this aspect showed that 7 out of the 10 teachers limited level of this component of PCK. The spiral nature of the curriculum is characterized by revisiting concepts and skills at different levels with increasing degrees of depth at each stage. According to CRDD (2012), the spiral nature of the Integrated Science curriculum has the benefit of matching scientific concepts and skills to students' cognitive development and therefore helps students to build a gradual mastery of scientific skills. This means the teachers' inability to portray the spiral nature of the curriculum in the classroom (e.g. they did not link the development of the concepts being taught with what the students had already been taught in previous years on the same topic). This is also an indication that they do not know that they had to match scientific concepts and skills to students' cognitive development. Lack of such knowledge and prior preparation to carefully match science concepts and skills to students' cognitive development will surely result in students having difficulty in understanding what they are taught. This will in turn lead to poor academic performance. It also shows a loophole in the Integrated Science teachers' PCK in the area of the Integrated Science curriculum (syllabus) as well.

Also results on teachers' knowledge of students understanding of Integrated Science show that majority of the teachers agreed that it is important for teachers' to know students' prior knowledge and connect it to new knowledge. This finding is confirmed by Svinicki (1994) who said it is helpful to know what knowledge students bring to the learning setting as this enables teachers to guide students unlearn their misconceptions which may interfere with the new knowledge (concept) to be learnt. According to Svinicki, "an incorrect bit of prior knowledge which is not corrected could keep the students from understanding an entire lecture [lesson]" (p. 2). Even though the teachers' showed knowledge of students' prior knowledge and connecting it to new knowledge, they were of the view that students' misconceptions be overlooked to enable systematic presentation of lessons. They were also of the view that it is not necessary for teachers to be aware of topics difficult to students in Integrated Science. From these it can be concluded that the teachers lacked knowledge of students understanding of Integrated Science. As Kim (2004) posited that knowledge of students' understanding comprises students' common errors and misconceptions, learning difficulties and confusions and their prior knowledge. These components with other factors work together to bring effective lesson presentation which leads to students' achievement. Therefore absence of any of these aspects alludes to lack of knowledge of students' understanding.

Again, the results on teachers' knowledge of instructional strategies for teaching Integrated Science indicate that the teachers agreed that using different ways/methods to develop students understanding in Integrated Science is crucial. In spite of this, they held the idea that when they adapted to variations in ability and background of students and also involved students in lessons, the lesson will be delayed. The teachers were in a dilemma as to whether the student-centred approach to teaching is effective or the teacher-centred approach. This means that there is a gap regarding the teachers' knowledge about instructional strategies for teaching Integrated Science. This assertion is supported by the findings of Halim and Meerah (2002) about Malaysian Trainee Integrated Science teachers that the teachers were unable to employ the appropriate teaching strategies required explaining scientific ideas.

Furthermore, the results on teachers' knowledge of assessment in Integrated Science showed that even though the teachers were aware that summative assessment is not the only means of testing students' understanding of Integrated Science, they did not have enough knowledge about assessment methods in Integrated Science. Formative assessment was virtually absent in their teaching. They rarely asked students questions to probe their understanding. They also provided no hands-on activities for students. Again, only on a few occasions were all students allowed to participate in lessons fully through contributions. Most of the teachers focused on contributions from a few brilliant students. This goes a long way to confirm the teachers' disagreement on adapting to variations in ability and background of students. Abell (2007), revealed that Science teachers lack crucial PCK including knowledge of assessment. This means that most Science teachers lack knowledge of assessment methods.

In a nutshell, the Integrated Science teachers lacked consistency among the four components of PCK discussed above and this affect their ability to present concepts well to students' understanding. This is what Ball et al. (2005) described as the "inability of many teachers to hear student' flexibility, represent ideas in multiple ways, connect content to contexts effectively, and think about things in ways other than their own" (p.86). Also PCK for effective teaching is the integration of all aspects of an Integrated Science teachers' knowledge in a highly complex way. Thus, lack of coherence among the components would be problematic within an individual's developing PCK and increased knowledge of a single component may not be sufficient to stimulate change in practice (Oliver & Park, 2008).

5.2 Influence of Integrated Science teachers' PCK on their teaching.

The results on this research question showed that the Integrated Science teachers generally lacked PCK and this had a negative influence on their teaching of the subject. The teachers agreed that questions should be posed to correct students' misconceptions in class. In contrast to this statement, the teachers agreed that students' misconceptions should be overlooked to enable systematic presentation of lessons in class and also agreed that all students should not be given the chance in the classroom to answer questions. This shows the level of confusion in the minds of the teachers about how to handle students' misconceptions in class. This, as mentioned earlier will negatively affect their teaching in the classroom. The teachers' content knowledge helped them to know that questions should be posed to correct students' misconceptions. According to Halim and Meerah (2002), teachers' level of content knowledge affects their awareness of students' possible misconceptions. Also, the teachers were of the view that adapting to variations in ability and background of students affect the lesson. This was confirmed during the classroom observation as 7 out of the 10 teachers showed limited knowledge in this aspect. Most of the teachers never adjusted their teaching strategies to suit the variations in ability and background of their students' to understand Integrated Science. According to Koehler and Mishra (2006), "a teacher with pedagogical content knowledge understands how students construct knowledge, acquire skills, and develop habits of mind and positive dispositions toward learning" (p.15). This implies that PCK helps Integrated Science teachers to be able to adjust their teaching strategies to suit all students in their class no matter how different their learning abilities are.

Again, the teachers agreed that involving students in the lesson fully delays the lesson and also teacher providing hands-on activities for students to learn Integrated Science wastes time. This might be the reason why they were neutral to the statement that the teacher should teach most of the time using the student-centred method. It was observed that the teachers used the teacher-centred approach to teaching and learning as they did most of the talking in the classroom. This approach which does not focus on student involvement in the lesson makes them passive/recipients rather than being active participants. When this happens the students will not be able to voice their misunderstandings which go a long way to affect their achievement in the Integrated Science. The level of PCK negatively influenced their lesson presentation. This assertion is buttressed by Ehindero 1990 (as cited Adedoyin, 2011) that teacher's delivery in the classroom is affected by the level PCK of subject matter he/she has acquired.

5.3 Students perception of the impact of Integrated Science teachers' PCK on their achievements in Integrated Science.

The results of responses of students to this research question showed that they perceived that Integrated Science teachers' PCK had significant effect on their achievements in Integrated Science. Using a mean value of 3.00 and above (see Appendix I), showed that JHS students perceived Integrated Science teachers' PCK as influencing their academic performance most in the following aspects:

- My teacher motivates us to learn Integrated Science.
- My teacher exhibits good knowledge of the subject.
- My teacher encourages all of us to participate in all classroom discussions.
- My teacher uses charts, diagrams, models, illustrations to show Integrated Science ideas (concepts).
- My teacher knows our previous knowledge and connects it to new knowledge.
- My teacher is aware of the topics that are difficult for us in the classroom.
- My teacher encourages us to think logically in solving problems.
- My teacher poses questions to correct our misconceptions.

Also using a mean value of 2.10 to 2.90, showed that JHS students perceived Integrated Science teachers' PCK as influencing their academic performance least in the following aspects:

- My teacher adapts to variations in ability and background of the students.
- My teacher explains Integrated Science (ideas) concepts clearly to us.
- My teacher provides us with the opportunity to think and respond to questions.
- My teacher represents Integrated Science in a way that we can comprehend.
- My teacher uses different methods to develop our understanding of Integrated Science.
- My teacher gives all students in the classroom chance to answer questions.

Educational researchers and teacher educators also are of the same view that PCK is very key to student achievement and it is very important for a teacher to have an upper hand over it in order to be able to represent lesson content to students effectively (Ball, Hill & Rowan 2005). This is because PCK enables a teacher to foresee difficulties that may be faced by students and thus prepare themselves with methods, explanations including useful and suitable analogies or representation and symbols in expressing certain lesson topics (Ball et al. 2001). Adediwura & Tayo (2007) stressed that where PCK is lacking, "teachers commonly paraphrase information in learners' textbooks or provide abstract explanations that are not meaningful to their students" (p. 2). Teachers' total control of subject matter and correct use of the subject matter in the process of teaching and learning will always show their level of PCK of the subject matter. In an Integrated Science classroom context, it is the duty of the teachers to play their required role until the desired results are achieved. This according to Ball et al. 2001 (as cited in Yusof & Zakaria, 2010) can be effectively done if teachers have both the content knowledge of the subject matter and as well as the pedagogical knowledge that fits the level of the students they are teaching.

> "The most essential factor in determining the result of the learning process from the teaching strategy is how far the strategy used could assist students in a meaningful lesson. Therefore, the most important question is not just how much a teacher can know about knowledge but how a teacher uses what he knows to perform the teaching task for effective learning outcomes". (p.1), Ball et al, 2001 (as cited in Yusof & Zakaria, 2010)

In conclusion, it found out that the students perceived their academic achievement in Integrated Science to increase when they are taught a teacher who exhibits good content knowledge, always reminds them to relate similar topics they have previously learnt to the new one they are learning and also uses charts, diagrams, models, illustrations to show Integrated Science concepts. They also perceived that when a teacher motivates them to learn Integrated Science, encouraged them to think logically in solving problems and are allowed to participate in classroom discussions they perform well.

CHAPTER SIX

SUMMARY, CONCLUSION, RECOMMENDATION AND SUGGESTION

6.0 Overview

This final chapter is presented under: summary of study finding, major finding, conclusions, recommendations and suggestion for further research.

6.1 Summary of the study

The study investigated the pedagogical content knowledge of Integrated Science teachers and its perceived impact on students' achievement at the Junior High Schools in the Atebubu-Amantin district in the Brong Ahafo Region of Ghana. The study sought to provide a heuristic basis for the mediocre scientific knowledge and poor performance shown by JHS graduates in Integrated Science.

The population comprised all professionally trained Integrated Science teachers and JHS 3 students in the public schools in the Atebubu-Amantin District. One hundred and forty-three (143) respondents comprising fifteen (15) Integrated Science teachers and one hundred and twenty-eight (128) JHS 3 students were sampled. Questionnaires and Observation schedule were the main instruments used in gathering data for the study. Descriptive statistics (means, standard deviation and frequencies) and percentages were used to analyse the respondents' responses to the questionnaire.

6.2 Summary of findings

General responses from the teachers showed that they lacked consistency in their levels of the four components of PCK (knowledge of Integrated Science Curriculum, knowledge of students understanding of Integrated Science, knowledge about instructional strategies for teaching Integrated Science and knowledge about assessment in Integrated Science) discussed in this study.

Based on the results and discussions presented in relation to the three (3) research questions, the following were the major findings:

1. Even though the Integrated Science teachers in the Atebubu-Amantin district used in the study were familiar with the curriculum, they lacked knowledge of a major aspect of the curriculum, which is its spiral nature.
2. Even though the Integrated Science teachers showed knowledge of students' prior knowledge and connected it to new knowledge, they were of the view that students' misconceptions be overlooked to enable systematic presentation of lessons.
3. The teachers were also of the view that it is not necessary for teachers to be aware of topics difficult to students in Integrated Science. This indicates that the teachers lacked knowledge of students' understanding of Integrated Science.
4. The teachers were in a dilemma as to whether the student-centred approach to teaching is effective or the teacher-centred approach.
5. Although the teachers were aware that summative assessment was not the only means of testing students understanding, they did not have enough knowledge about assessment methods in Integrated Science as they rarely asked students' questions to probe their understanding.
6. The teachers' lack of PCK had a negative influence on their teaching of the subject for example; they did not provide hands-on activities for students during the lessons.

7. The JHS students perceived that Integrated Science teachers' PCK had significant effect on their achievements in Integrated Science. The findings indicated that JHS students perceived that Integrated Science teachers' PCK has an impact on their academic performance in the following areas: motivating students to learn Integrated Science, teacher exhibiting good knowledge of Integrated Science, encouraging all students to participate in all classroom discussions, using charts, diagrams, models, illustrations to show Integrated Science ideas (concepts), knowing the previous knowledge of students and connecting it to new knowledge, aware of the topics that are difficult for students in the classroom, encouraging students to think logically in solving problems, posing questions to correct students misconceptions and allowing students to fully participate in lessons.

6.3 Conclusion

Based on the findings of the study the following conclusions were arrived at:

It was realised that the Integrated Science teachers in the Atebubu-Amantin district used in the study lacked consistency among the levels of the components of the PCK studied and this negatively affected their ability to present concepts well for students to comprehend. The lack of coherence among the components of PCK is challenging especially within an individual's developing PCK and therefore increased knowledge of a single component may not be enough to encourage change in practice (Park & Oliver, 2008). This could be the reason why the JHS graduates show mediocre scientific knowledge and perform poorly in Integrated Science in the BECE.

It was also realised that students perceive Integrated Science teachers' PCK to have a significant impact on their academic achievements in Integrated Science. This has been emphasised by most educational researchers and teacher educators. For instance, according to Hill, Rowan & Ball (2005), a teacher's PCK is very crucial and it is very important for a teacher to have upper hand over it in order to be able to represent lesson content to students effectively for them to excel.

6.4 Recommendations

Based on the finding of the study through the use of questionnaire and observation schedule, the following recommendations have been made:

1. In-service trainings and courses should be organised regularly for JHS Integrated Science teachers in the Atebubu-Amantin district on ways of improving their PCK.
2. The teachers need to be reminded of their key function which is to facilitate learning.
3. There is the need to plan and conduct effective professional development initiatives, including pre- and in-service training, to transform the teachers' epistemologies in line with the current theories of teaching and learning.
4. Ghana National Association of Science Teachers (GAST) should also organised orientations, seminars and workshops for newly trained teachers from the Universities and Colleges of Education who are posted to district on how to effectively teach the subject (Integrated Science).
5. Universities and Colleges of Education should provide a broad chance to Integrated Science teachers to develop their PCK.

6.5 Suggestions for further research

The research took place at the Atebubu-Amantin District in the Brong Ahafo Region of Ghana and is therefore not representative enough for the whole region and the country at large. It is therefore recommended that for a more complete study on teachers' PCK; other districts in the Region as well as the other Regions need to be researched into to help evaluate Integrated Science teachers PCK at the JHS level.

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APPENDICES

APPENDIX A

TEACHERS' QUESTIONNAIRE

TQ No.

Dear colleague,

I am conducting a research into *Integrated Science Teachers' Pedagogical Content Knowledge (PCK) and Its Perceived Impact on JHS Students Achievement in Integrated Science.* The topic is much under-researched in our educational sector Ghana, and that is why I intend to explore the area. It is aimed at identifying ways of helping Science teachers in general, but specifically those of JHS, to present the content of the Integrated Science curriculum in the best possible manner to their students.

The challenges you face in teaching the current generation cannot be over emphasized. It is hoped the results of this would be most beneficial to you and all who teach Science.

I am therefore asking you to involve yourself in this research to make it successful.

The questionnaire below forms part of forms part of the research. Please kindly respond appropriately by following the instruction below.

Thank you.

SECTION A

Demographic Data

Please kindly tick (√) the responses that best correspond to your answer in the space provided.

1. Sex: Male [ ]

Female [ ]

2. Age:

Below 18 years [ ]

19-25 years [ ]

26-30 years [ ]

31-35 years [ ]

36-40 years [ ]

Above 40 years [ ]

3. Your highest level of educational qualification.

[ ] Master's degree

[ ] First degree

[ ] Diploma

[ ] Teacher Cert "A"

[ ] SSCE/WASSCE

4. Kind of Institution attended for your highest educational qualification.

[ ] University (please specify e.g. UEW, etc)…………………………

[ ] College of Education

[ ] Polytechnic

[ ] Senior High School

[ ] Technical School

[ ] Vocational School

Others (please specify)……………………………………………………

5. How long have you been teaching Integrated Science at the Junior High School level?

[ ] less than a year
[ ] 1 - 5years
[ ] 6 - 10 years
[ ] 11years and above

SECTION B

Please read carefully and complete the following by placing a tick (√) in one space only.

Key:

Strongly disagree (SD = 1), Disagree (D = 2), Not sure (NS = 3), Agree (A = 4), Strongly agree (SA = 5)

S/N	Questions	SD	D	NS	A	SA
6	It is not necessary for the teacher to be aware of the topics difficult for students in Integrated Science.					
7	Integrated Science is concerned about curiosity, creativity in solving problems and critical thinking.					
8	Summative assessment is the only way to test students understanding.					
9	I use different ways/methods to develop students' understanding of Integrated Science.					
10	The teacher has to ask students questions for proper understanding in the classroom.					
11	Teacher adapting to variations in ability and background of students does not affect the lesson.					
12	Students' misconceptions should be overlooked by teachers to enable systematic presentation of a lesson.					
13	Teacher providing hands-on activities for students to learn Integrated Science waste time.					
14	The Integrated Science curriculum is based on the Spiral Approach.					
15	Involving students in the lesson fully delays the lesson.					
16	The teacher should give all students in the classroom a chance to answer questions.					
17	Teacher knowing students' prior knowledge and connecting it					

	to new knowledge is an effective way of teaching.					
18	Integrated Science does not recognise the vulnerability of the natural environment.					
19	The teacher should teach most of the time using the student centred method.					
20	Integrated Science is not necessarily the holistic study of the science disciplines.					
21	Teacher should pose questions to correct students' misconceptions.					

APPENDIX B

STUDENTS' QUESTIONNAIRE

SQ No.

SECTION A

Demographic Data

Please kindly tick (√) the responses that best correspond to your answer in the space provided.

1. Sex: Male [ ]

Female [ ]

2. Age:

12-13 years [ ]

14-15 years [ ]

16-17 years [ ]

18 and above [ ]

SECTION B

Please read carefully and complete the following by placing a tick (√) in ***one*** *space* ***only*** *about your Integrated Science teacher.*

Key:

Strongly disagree (SD = 1), Disagree (D = 2), Not sure (NS = 3), Agree (A = 4), Strongly agree (SA = 5)

S/N	Questions	SD	D	NS	A	SA
3	My teacher knows our previous knowledge and connect it to new knowledge.					
4	My teacher uses charts, diagrams, models, illustrations to show Integrated Science ideas (concepts).					
5	My teacher poses questions to correct our misconceptions.					
6	My teacher exhibits good knowledge of the subject.					
7	My teacher is aware of the topics that are difficult for us in the classroom.					

8	My teacher uses different methods to develop our understanding of Integrated Science.					
9	My teacher explains Integrated Science (ideas) concepts clearly to us.					
10	My teacher represents Integrated Science in a way that we can comprehend.					
11	My teacher gives all students in the classroom chance to answer questions.					
12	My teacher provides us opportunity to think and respond to questions.					
13	My teacher promotes us to think logically in solving problems.					
14	My teacher provides hands-on activities for us to learn the subject.					
15	My teacher possess a deep knowledge of how to represent the subject matter to us.					
16	My teacher provides responses that are not relevant to the questions.					
17	My teacher adapts to variations in ability and background of the students.					
18	My teacher encourages all of us to participate in all classroom discussions.					
19	My teacher asks us many questions for proper understanding in the classroom.					
20	My teacher does not use the science textbook at all.					
21	My teacher always teach without allowing us to participate in the lesson.					
22	My teacher motivates us to learn Integrated Science.					

APPENDIX C

OBSERVATION SCHEDULE

Teacher: ______________________ **School:** ______________________

Subject: ______________________ **Topic:** ______________________

Date Observed: ____________________________

PCK Component	Levels of performance			
	Limited (1)	Basic (2)	Proficient (3)	Exemplary (4)
1.Knowledge of Students Understanding of Integrated Science (KSUIs)	Many attempts to overlook students' misconceptions. No understanding of student common learning difficulties. No knowledge on students' prior knowledge and connecting it to new knowledge.	Some attempts to overlook students' misconceptions. Narrow understanding of student common learning difficulties. Narrow knowledge on students' prior knowledge and connecting it to new knowledge.	Few attempts to overlook students' misconceptions. Adequate understanding of student common learning difficulties. Adequate knowledge on students' prior knowledge and connecting it to new knowledge.	No attempt to overlook students' misconceptions. Sophisticated understanding of student common learning difficulties. Sophisticated knowledge on students' prior knowledge and connecting it to new knowledge.

	No attempt to pose questions to correct students' misconceptions.	Few attempts to pose questions to correct students' misconceptions.	Some attempts to pose questions to correct students' misconceptions.	Many attempts to pose questions to correct students' misconceptions.

PCK Component	**Levels of performance**			
	Limited (1)	Basic (2)	Proficient (3)	Exemplary (4)
2.Knowledge of Integrated Science Curriculum (KIsC)	No attempt to encourage creativity and critical thinking through activities and questioning.	Few attempts to encourage creativity and critical thinking through activities and questioning.	Some attempts to encourage creativity and critical thinking through activities and questioning.	Many attempts to encourage creativity and critical thinking through activities and questioning.
	No attempt to integrate concepts to make the subject holistic to students.	Few attempts to integrate concepts to make the subject holistic to students.	Some attempts to integrate concepts to make the subject holistic to students.	Many attempts to integrate concepts to make the subject holistic to students.
	No understanding of the application of concepts in everyday life.	Narrow understanding of the application of concepts in everyday life.	Adequate understanding of the application of concepts in everyday life.	Sophisticated understanding of the application of concepts in everyday life.

	No understanding of the curriculum as spiral.	Narrow understanding of the curriculum as spiral.	Adequate understanding of the curriculum as spiral.	Sophisticated understanding of the curriculum as spiral.

PCK Component	**Levels of performance**			
	Limited (1)	Basic (2)	Proficient (3)	Exemplary (4)
3.Knowledge of Assessment	No questions to probe student understanding. No attempt to provide hands-on activities for students to learn Integrated Science. No attempt to give all students in the classroom chance to answer questions.	Few questions to probe student understanding. Few attempts to provide hands-on activities for students to learn Integrated Science. Few attempts to give all students in the classroom chance to answer questions.	Some questions to probe student understanding. Some attempts to provide hands-on activities for students to learn Integrated Science. Some attempts to give all students in the classroom chance to answer questions.	Many questions to probe student understanding. Many attempts to provide hands-on activities for students to learn Integrated Science. Many attempts to give all students in the classroom chance to answer questions.

PCK Component	**Levels of performance**			
	Limited (1)	Basic (2)	Proficient (3)	Exemplary (4)
4.Knowledge of Instructional Strategies (KIS)	No rationale for instructional strategies and representations in connection with student understanding	Weak rationale for instructional strategies and representations in connection with student understanding	Adequate rationale for instructional strategies and representations in connection with student understanding	Strong rationale for instructional strategies and representations in connection with student understanding
	No attention paid to student understanding, misconceptions, and learning difficulties	Little attention paid to student understanding, misconceptions, and learning difficulties	Some attention paid to student understanding, misconceptions, and learning difficulties	Much attention paid to student understanding, misconceptions, and learning difficulties
	No integration of the understanding of student common prior knowledge including misconceptions into instructional strategies and representations.	Integration of the understanding of student common prior knowledge including misconceptions into instructional strategies and representations in a restricted way.	Integration of the understanding of student common prior knowledge including misconceptions into instructional strategies and representations in an appropriate way.	Integration of the understanding of student common prior knowledge including misconceptions into instructional strategies and representations in an effective way.

	No integration of the understanding of student common learning difficulties into instructional strategies and representations.	Integration of the understanding of student common learning difficulties into instructional strategies and representations in a restricted way	Integration of the understanding of student common learning difficulties into instructional strategies and representations in an appropriate way	Integration of the understanding of student common learning difficulties into instructional strategies and representations in an effective way

APPENDIX D

Reliability Statistics of teachers' questionnaire.

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.721	0.705	21

APPENDIX E

Reliability Statistics of students' questionnaire.

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.683	0.687	22

APPENDIX F

The influence of Integrated Science teachers' PCK on their teaching.

No.	Statement	N	Mean	Std. Deviation
6	It is not necessary for the teacher to be aware of the topics difficult for students in Integrated Science.	15	3.33	1.759
8	Summative assessment is the only way to test students understanding.	15	2.40	1.056
10	The teacher has to ask students questions for proper understanding in the classroom.	15	3.93	0.961
11	Teacher adapting to variations in ability and background of students does not affect the lesson.	15	2.47	1.356
12	Students' misconceptions should be overlooked by teachers to enable systematic presentation of a lesson.	15	3.93	1.280
13	Teacher providing hands-on activities for students to learn Integrated Science waste time.	15	4.20	0.775
15	Involving students in the lesson fully delays the lesson.	15	4.13	0.990
16	The teacher should give all students in the classroom chance to answer questions.	15	2.67	1.633
17	Teacher knowing students' prior knowledge and connecting it to new knowledge is an effective way of teaching.	15	4.07	0.961
19	The teacher should teach most of the time using the student-centred method.	15	3.27	1.335
21	Teacher should pose questions to correct students' misconceptions.	15	4.33	0.488

APPENDIX G

Sample Statistics of students' responses to questionnaire

No.	Statements	N	Mean	Std. Deviation
3	My teacher knows our previous knowledge and connect it to new knowledge.	124	3.77	1.162
4	My teacher uses charts, diagrams, models, illustrations to show Integrated Science ideas (concepts).	124	3.96	1.252
5	My teacher poses questions to correct our misconceptions.	124	3.57	1.135
6	My teacher exhibits good knowledge of the subject.	124	3.99	1.266
7	My teacher is aware of the topics that are difficult for us in the classroom.	124	3.72	1.253
8	My teacher uses different methods to develop our understanding of Integrated Science.	124	2.46	1.278
9	My teacher explains Integrated Science (ideas) concepts clearly to us.	124	2.60	1.413
10	My teacher represents Integrated Science in a way that we can comprehend.	124	2.48	1.322
11	My teacher gives all students in the classroom chance to answer questions.	124	2.10	1.107
12	My teacher provides us with the opportunity to think and respond to questions.	124	2.49	1.291
13	My teacher encourage us to think logically in solving problems.	124	3.63	1.310
14	My teacher provides hands-on activities for us to learn the subject.	124	2.88	1.412
15	My teacher possess a deep knowledge of how to represent the subject matter to us.	124	3.06	1.489
16	My teacher provides responses that are not	124	2.86	1.212

	relevant to the questions.			
17	My teacher adapts to variations in ability and background of the students.	124	2.65	1.313
18	My teacher encourages all of us to participate in all classroom discussions.	124	3.98	1.122
19	My teacher asks us many questions for proper understanding in the classroom.	124	2.79	1.450
20	My teacher does not use the science textbook at all.	124	2.85	1.354
21	My teacher always teaches without allowing us to participate in the lesson.	124	3.54	1.346
22	My teacher motivates us to learn Integrated Science.	124	4.12	1.240

APPENDIX H

Analysis of Students' responses to the questionnaire on the impact of Integrated Science teachers' PCK in relation to their achievements in Integrated Science.

	Test Value = 3					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
3. My teacher knows our previous knowledge and connects it to new knowledge.	7.339	123	0.000	0.766	0.56	0.97
4. My teacher uses charts, diagrams, models, illustrations to show Integrated Science ideas (concepts).	8.536	123	0.000	0.960	0.74	1.18
5. My teacher poses questions to correct our misconceptions.	5.619	123	0.000	0.573	0.37	0.77
6. My teacher exhibits good knowledge of the subject.	8.728	123	0.000	0.992	0.77	1.22
7. My teacher is aware of the topics that are difficult for us in the classroom.	6.378	123	0.000	0.718	0.50	0.94
8. My teacher uses different methods to develop our understanding of Integrated Science.	-4.709	123	0.000	-0.540	-0.77	-0.31
9. My teacher explains Integrated Science (ideas) concepts clearly to us.	-3.114	123	0.002	-0.395	-0.65	-0.14
10. My teacher represents Integrated Science in a way that we can comprehend.	-4.347	123	0.000	-0.516	-0.75	-0.28
11. My teacher gives all students in the classroom chance to answer questions.	-9.082	123	0.000	-0.903	-1.10	-0.71
12. My teacher provides us with the	-4.382	123	0.000	-0.508	-0.74	-0.28

opportunity to think and respond to questions.						
13. My teacher encourages us to think logically in solving problems.	5.349	123	0.000	0.629	0.40	0.86
14. My teacher provides hands-on activities for us to learn the subject.	-0.954	123	0.342	-0.121	-.37	0.13
15. My teacher possess a deep knowledge of how to represent the subject matter to us.	.422	123	.674	0.056	-0.21	0.32
16. My teacher provides responses that are not relevant to the questions.	-1.260	123	.210	-0.137	-0.35	0.08
17. My teacher adapts to variations in ability and background of the students.	-2.941	123	.004	-0.347	-0.58	-0.11
18. My teacher encourages all of us to participate in all classroom discussions.	9.682	123	.000	0.976	0.78	1.18
19. My teacher asks us many questions for proper understanding in the classroom.	-1.610	123	.110	-0.210	-0.47	0.05
20. My teacher does not use the science textbook at all.	-1.194	123	.235	-0.145	-0.39	0.10
21. My teacher always teaches without allowing us to participate in the lesson.	4.471	123	.000	0.540	0.30	0.78
22. My teacher motivates us to learn Integrated Science.	10.065	123	.000	1.121	0.90	1.34

APPENDIX I

Rearranging the sample statistics of students' responses that were significant from the largest mean value to the lowest mean value.

Items	The Integrated Science teachers PCK the JHS students perceived to have a significant impact on their achievements in Integrated Science.	Mean	Std. Deviation	Level of significance
22	My teacher motivates us to learn Integrated Science.	4.12	1.240	0.000
6	My teacher exhibits good knowledge of the subject.	3.99	1.266	0.000
18	My teacher encourages all of us to participate in all classroom discussions.	3.98	1.122	0.000
4	My teacher uses charts, diagrams, models, illustrations to show Integrated Science ideas (concepts).	3.96	1.252	0.000
3	My teacher knows our previous knowledge and connect it to new knowledge.	3.77	1.162	0.000
7	My teacher is aware of the topics that are difficult for us in the classroom.	3.72	1.253	0.000
13	My teacher encourages us to think logically in solving problems.	3.63	1.310	0.000
5	My teacher poses questions to correct our misconceptions.	3.57	1.135	0.000
21	My teacher always teach without allowing us to participate in the lesson.	3.54	1.346	0.000
17	My teacher adapts to variations in ability and background of the students.	2.65	1.313	0.004
9	My teacher explains Integrated Science (ideas) concepts clearly to us.	2.60	1.413	0.002
12	My teacher provides us with the opportunity to think and respond to	2.49	1.291	0.000

	questions.			
10	My teacher represents Integrated Science in a way that we can comprehend.	2.48	1.322	0.000
8	My teacher uses different methods to develop our understanding of Integrated Science.	2.46	1.278	0.000
11	My teacher gives all students in the classroom chance to answer questions.	2.10	1.107	0.000

Significant at 0.05 alpha level

APPENDIX J

UNIVERSITY OF EDUCATION, WINNEBA
DEPARTMENT OF SCIENCE EDUCATION
[illegible]

August 6, 2015.

Dear Sir,

TO WHOM IT MAY CONCERN
INTRODUCTORY LETTER

The bearer of this letter, Robert Kwadwo Siameh with Index Number 7130130026 is a student offering Master of Education in Science Education in the Department of Science Education in the above University.

He is conducting a research on *"Teachers' Pedagogical Content Knowledge in Integrated Science and its Impact on Students' Achievement at the Junior High Schools in the [illegible] District in the Brong Ahafo Region of Ghana"*

Your school has been selected as part of his sampling area.

I hope you would assist him to do a good thesis write-up.

Thank you.

DR. K. D. TAALE
Head of Department