UNIVERSITY OF EDUCATION, WINNEBA

NATURAL SCIENCE TEACHERS' CURRICULUM KNOWLEDGE, SELF-EFFICACY BELIEFS, AND CLASSROOM PRACTICES IN THE GOMOA EAST DISTRICT

MARTIN AKO

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DECLARATION

Student's Declaration

I, MARTIN AKO, declare that this dissertation, with the exception of quotations and references contained in published works which have all been identified and acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

Signature:……………………

Date:………………………..

Supervisor's Declaration

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of Dissertation as laid down by the University of Education, Winneba.

NAME OF SUPERVISOR : ERNEST I.D. NGMAN-WARA (PhD)

SIGNATURE :…………………………………

DATE:…………………………………………

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DEDICATION

This thesis is dedicated to my partner the Holy Spirit, My dad, Mr. S.K Mawu Ako and beloved Winnifred Naana Yekple for their support both physical and spiritually.

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ABSTRACT

The study sought to explore natural science teachers' curriculum knowledge, self-efficacy beliefs and their classroom instructional and assessment practices in the Gomoa East District of the Central Region of Ghana. A mixed method sequential explanatory research design was used for the study. Data were collected by administering natural science teachers' curriculum knowledge (NSTCK) and the science teaching self-efficacy beliefs (STEBI) questionnaires to 232 natural science teachers. Quantitative data were analysed using descriptive statistics, and Pearson Product-Moment Correlation functions of the Statistical Product for Service Solutions (SPSS) version 20. In the qualitative phase of the study, inquiry-based observational guide and semi-structured interview guide were used to explore in-depth information on natural science teacher's curriculum knowledge, self-efficacy beliefs and classroom practices. The findings revealed that, majority of the teachers' had low knowledge of the natural science curriculum. It was also found that only professional qualification had a slight positive correlation with natural science teachers' content knowledge of the primary one curriculum. Also, natural science teachers had a very high PSTE and STOE of the self-efficacy beliefs scale though the interview results indicated that, some of the teachers had low self-efficacy beliefs to teach natural science. The results further indicated that majority of natural science teachers generally adopted child-centred teaching practices at the introduction stage of the lesson but used more teacher-centred instructional strategies for presentation and evaluation of lessons. They did not adequately carry out formative assessment as recommended by the natural science curriculum. It was recommended that in-service programmes, workshops, seminars and short courses should be organized on the natural science curriculum and SBA to improve teachers' knowledge of the natural science curriculum and their skills in assessment practices.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter presents the introduction to the study. It comprises the background to the study, statement of the problem, purpose of the study, objectives of the study, research questions, significance of the study, delimitation, limitations, definition of terms and organization of the study.

1.1 Background to the Study

Recent reforms in science education aim at preparing individuals for the rapidly developing and advancement of technology and industrialization all over the world. This is evident in the 2007 educational reforms in Ghana which aim, among other things, to equip children with the necessary process skills and attitudes that will provide a strong foundation for further study in science at the upper primary level and beyond as well as provide the young person with the interest and inclination toward the pursuit of scientific work through developing the spirit of curiosity, creativity and critical thinking (Curriculum Research and Development Division [CRDD], 2007). This objective is corroborated by the American Association of Advancement of Science [AAAS] (1993) who describe the goals of school science as helping students to:

- Experience the richness and excitement of knowing about and understanding the natural world;
- use appropriate scientific processes and principles in making personal decisions;

- engage intelligently in public discourse and debate about matters of scientific and technological concern and,
- increase their economic productivity through the use of the knowledge, understanding, and skills of the scientifically literate person in their careers.

The government white paper on the Educational Review Report (2002) expanded Universal Basic Education to include two years of Kindergarten. The 2007 educational reforms placed much emphasis on the study of science right from the Kindergarten level by incorporating science concepts into the environmental studies syllabus (Government of Ghana, 2002). With particular reference to science education, the reforms absorbed the environmental studies which was taught at the lower primary into the kindergarten curriculum and replaced it with Natural Science and Integrated Science at the upper primary (4-6) and the Junior High School level.

Teachers are usually faced with problems of adjusting to curriculum innovation especially in situations where many teachers at the lower primary level are classroom teachers who teach all subjects (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2010).The success of Ghana's educational reforms and innovations depend on the self-confidence of teachers to implement the innovations outlined in the curriculum in their daily teaching (Azar, 2010).Teachers who are the actual curriculum implementers need to have adequate knowledge of the demands of the curriculum innovations as well as develop high self-efficacy for bringing these aims and aspirations to reality through their classroom practices (Levit, 2001). However, curriculum innovations come with challenges to the teacher. Teachers are usually faced with the problem of adjusting to new content, new instructional approaches, and assessment techniques whenever there is innovation in the existing curriculum. Implementing new instructional approaches means that teachers have to shift from their old ways of presenting lessons to new approaches.

This is in consonance with the findings of Rondinelli, Middleton and Verspoor (1990) that implementing curriculum innovations have been difficult even in developed countries like America who have highly skilled, motivated, and dedicated teachers who receive adequate continuous professional development and physical resources for implementation. Implementation of the natural science curriculum is therefore likely to prove more difficult in a developing country like Ghana which lacks adequate physical infrastructure, and experienced professionals needed for successful implementation.

Teachers' content knowledge and training are other factors which influence their ability to put innovations into practice (Rogan & Grayson, 2003). This is because teachers with low curriculum knowledge may present wrong ideas to pupils, use inappropriate teaching materials and instructional approaches. On the other hand, teachers with adequate curriculum knowledge are able to effectively use instructional materials, and instruction and assessment. Teachers' knowledge of the curriculum will therefore play a vital role in successful implementation of the innovations.

According to Bandura (1997), self-efficacy is a person's belief in his/her ability to succeed in specific situations and accomplish certain tasks successfully. A person's sense of self-efficacy is a major determinant of how the person approaches set targets, tasks, and challenges (Luszczynska & Schwarzer, 2005). Efficacy to teach increases the teachers' effort and persistence towards challenging tasks, therefore, increasing the likelihood that they will be completed (Axtell & Parker, 2003).

It is believed that a person who has high sense of self-efficacy is more willing and able to undertake difficult tasks, to persist longer at them, and to spend more time and effort in achieving them (Witt-Rose, 2003). On the other hand, a person with low self-efficacy beliefs will likely give up on the same problem because he/she thinks it is beyond his or her capability (Allen, 2010).Teacher self-efficacy belief is the teacher's belief in his or her ability and capacity to influence student learning, performance, and motivation (Tschannen-Moran & Hoy, 2001). Self-efficacy beliefs might drive practice in that teachers who have the belief that they lack skills in teaching science in the classroom may develop a dislike for science teaching and lead teachers to avoiding the teaching science if possible (Enoch & Riggs, 1990).

A teachers' self-efficacy belief is one of the most fundamental elements for effective teaching. This is because teachers' self-efficacy has been associated with student motivation to learn, teachers' adoption of innovations in teaching, and teachers' competence as well as effective classroom management strategies of the teacher and time spent on different subjects (Woolfolk & Hoy, 2000).As indicated by Hattie (2012), teachers' beliefs and commitments are the greatest influence on student achievement over which we can have some control. He further indicated that the differences between low and high achieving teachers are primarily related to the professional knowledge expectations that teachers have when they decide on the key issues of teaching. This means that teachers' curriculum knowledge will have some influence on their classroom practices.

Azar (2010) points out that professional experience and personal attributes of teachers have significant effect on the teaching and learning of science. Other studies also points out that teachers' self-efficacy beliefs which are reflected in classroom practices have an important effect on the quality of science teaching and learning in schools, hence the quality of students (Tobin, Tipin & Gallard, 1994). Though many studies have been done on teacher's self-efficacy beliefs regarding science teaching (Isler & Cakiroglu, 2009; Garvis & Pendergast, 2011; Sarikaya,2004), there has not been enough studies to establish the relationship between self-efficacy, curriculum knowledge and classroom practices. Many studies on self-efficacy beliefs focus on pre-service teachers (Ozdilek & Bulunuz, 2009; Sarikaya, 2004; Kahraman, Yilmaz, Erkol & Yalcin, 2013). Moreover, there are limited studies on teachers' self-efficacy beliefs regarding science teaching in Ghana.For instance, Ngman-Wara (2012) studied Pre-service secondary teachers' self-efficacy beliefs while Ngman-Wara and Edem (2016) also studied pre-service primary school science teachers' self-efficacy beliefs in Ghana. It seems there is no study on in-service natural science teachers' self-efficacy beliefs in Basic Schools in the Gomoa East District of the Central Region of Ghana. Also, there are limited studies on science teachers' curriculum knowledge in Ghana (Appiah, 2015). It seems there is no study on natural science teachers' curriculum knowledge in the Gomoa East District of the Central Region of Ghana.

1.2 Statement of the Problem

Curriculum innovations present enormous challenges to teachers who have to quickly adjust to the new content of the curriculum, instructional approaches, materials as well as assessment strategies. Natural science introduced in the science curriculum reform in 2007 replaced the environmental studies at Basic One to Three. This has a number of implications for teachers. Most teachers at the lower primary are classroom teachers who teach all the subjects in the class. They are mostly generalist from the colleges of education who may not be conversant with the natural science content. In other words, most teachers at the lower primary level are not specialist science teachers. Thus, they don't have any special training in science. This will pose major challenges to teachers and they will have to learn the content of science and adjust to teaching approaches required by the curriculum. The new instructional strategies that are outlined in the curriculum means that teachers have to significantly shift from the old ways of teaching. The curriculum emphasized enquiry processes of science teaching (CRDD, 2007). These processes are learner-centred but instructional approaches in Ghanaian science classrooms are mostly teacher-centred (Ngman-Wara, 2011; Osei, 2004). This means that teachers will have to shift from teacher-centred instructional approaches to leaner-centred approaches if the natural science has to be implemented in the classroom as recommended.

Teachers are considered to have a critical role for the realization of the ideas, aims and goals outlined in the natural science curriculum (Isler& Cakiroglu, 2009). No matter what the curriculum suggests, it is the teacher who makes the ultimate decisions about what goes on in the classroom so the teacher has a critical role in the implementation of the natural science curriculum.

Researchers believe that low level of teachers' background science content knowledge, curriculum knowledge, and pedagogical knowledge as well as assessment strategies significantly contribute to basic school teachers' hesitancy, and possible inability to provide effective science instruction in their classrooms (NES, 2011). Also, the success of pupils in science education and the progress of a nation will depend on science teachers who ensure the development of scientific concepts in learners right from the lower primary level (National Science Forum, 2004). However, UNESCO (2010) pointed out that when teachers teach all subjects, as is the case with the lower primary schools in Ghana, they tend to focus more on subjects they are more comfortable with and devote little time to other subjects which they are not comfortable with.

Whenever new content is introduced into the existing curriculum, there is always a natural apprehension by teachers to accept the proposed change. There is always a feeling of inadequacy in the teacher about his/her teaching method and/or his/her job insecurity (Fullan, 2007). Such imposed curriculum changes have often led to low level of self-efficacy and eventually failed curriculum implementation. This is because curriculum innovation is usually accompanied by increased accountability, responsibilities, increased workload, and sometimes lack of support and direction from administration (Benham, 2002; Evans, 2002).

Therefore in order to bring about effective implementation of curriculum innovation, it is important to narrow the gap between the intended and the enacted curriculum and assist teachers cope with the innovation. This can be done when the teachers have adequate knowledge of the curriculum or they are equipped with the content of the curriculum through workshops and in-service training. It is necessary to resolve the problem of how natural science teachers' curriculum knowledge and self-efficacy beliefs shape the implementation of the intended natural science curriculum. As stated elsewhere, teachers' knowledge of the curriculum and self-efficacy beliefs generally influence curriculum implementation. Also, Sarikaya (2004) pointed out that teachers with high self-efficacy are more likely to use inquiry-based and student-centred teaching strategies such as group work. On the other hand, teachers with low self-efficacy are more likely to use teacher-centred teaching strategies such as lecture method and reading notes from textbooks. Azar (2010) pointed out that science teachers self-efficacy positively affects the achievements of the students while Tschannen-Moran and Woolfolk-Hoy (2001) established that teachers who are more comfortable with science are more likely to devote more time to teaching it. Smith (1996) also established that teachers' sense of efficacy and curriculum innovations are closely related. In other words, the changes teachers apply to their instructional approaches and adaptation to curriculum innovations require that they have a high sense of self-efficacy.

It is therefore important to investigate natural science teacher's curriculum knowledge, self-efficacy beliefs as well as their classroom instructional practices.

This is particularly important since many stakeholders have blamed the persistent failures of students on science teachers. This study aims to explore in-service natural science teachers' self-efficacy beliefs, their knowledge of the natural science curriculum and their classroom instructional practices.

1.3 Purpose of the Study

This study sought to explore natural science teachers' knowledge of the natural science curriculum, self-efficacy beliefs towards teaching natural science and their classroom practices in the Gomoa East District.

1.4 Objectives of the Study

The objectives of the study were to:

1. ascertain natural science teachers' content knowledge of the natural science curriculum.
2. determine the relationship that exists between natural science teachers' background factors and their content knowledge of the natural science curriculum
3. determine the level of natural science teachers' self-efficacy beliefs regarding natural science teaching.
4. examine natural science teachers' classroom instructional practices

1.5 Research questions

The following research questions were formulated to guide the study:

1. What are natural science teachers' content knowledge of the natural science curriculum?
2. What relationship exists between natural science teachers' background factors and their content knowledge of the natural science curriculum?
3. What are the levels of natural science teachers' self-efficacy beliefs regarding natural science teaching?
4. What are natural science teachers' classroom instructional practices?

1.6 Significance of the Study

The findings of this study are likely to inform the Gomoa East District Education Directorate and stakeholders in the District about natural science teachers' curriculum knowledge, their level of self-efficacy beliefs regarding science teaching and their classroom instructional practices. The findings would inform in-service education and training programmes or workshops if the natural science teachers have inadequate knowledge of the curriculum. The findings of the study may serve as a basis to evaluate the implementation of the 2007 natural science curriculum in the Gomoa East District. The findings of the study may contribute to the body of literature on in-service science teachers' curriculum knowledge, self-efficacy beliefs and classroom instructional practices in Ghana.

1.7 Delimitation

The study was delimited to teacher's self-efficacy beliefs, curriculum knowledge and classroom practices of natural science teachers in the Gomoa East District of the Central Region, Ghana. The study was restricted to natural science teachers in the Gomoa East District which is one of the twenty districts in the Central

Region because the District is new and may have peculiar problems. Additionally, the researcher is familiar with the environment of the study area and would get assistance from teachers and circuit supervisors to ease the collection of data.

1.8 Definition of terms

Natural science teachers: Natural science teachers are teachers who teach natural science at the lower primary level (1 - 3)

Curriculum knowledge: Curriculum knowledge refers to teachers' knowledge of the natural science curriculum materials content, instructional approaches, as well as recommended assessment strategies outlined in the curriculum.

Classroom Practices: It involves teachers' instructional approaches and assessment strategies used by teachers in their classrooms.

1.9 Organization of the Study

The study was organized into six chapters. Chapter one looked at the introduction of the study. It comprised the background to the study, statement of the problem, purpose of the study, research objectives and research questions. It also looked at the significance of the study, delimitation, and organization of the study. Chapter two involved review of available literature relevant to the study while chapter three focused on the methodology which comprised the research design, population, sampling and sample size, instrument for data collection and the procedure used in data analysis. Chapter four dealt with results while chapter five dealt with discussion of findings. The final chapter involved the summary, conclusion and recommendations as well as suggested areas for further research.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter provides a comprehensive literature review on the following sub-headings: theoretical framework, the concept of teacher self-efficacy belief, the concept of teacher curriculum knowledge, classroom teachers' instructional and assessment practices, and summary of the chapter.

2.1 Theoretical Framework

The theoretical framework underpinning the study was hinged on Bandura's Social cognitive theory and Shulman's theory of pedagogical content knowledge (PCK). A sound and effective curriculum enactment and classroom instruction and assessment practice must be rooted in a well-researched theoretical framework. Successful curriculum enactment deals with interactions of several constructs. Examples include the construct of educational belief which comprises teacher's efficacy, nature of knowledge, self-concept and self-efficacy (Ngman-Wara, 2012) and the construct of teacher curriculum knowledge.

Shulman (1986) defines curriculum knowledge as the understanding of the alternative form of curriculum for the teacher's special area and the ways in which they are embodied in different texts and materials. Magnusson, Krajick and Borko (1999) also view science curriculum knowledge as knowledge of mandated goals and objectives of the curriculum and knowledge of specific curriculum programmes and materials. Shulman (1986) introduced the concept of Pedagogical Content Knowledge as an element of knowledge base for teaching. Key elements in Shulmans' conception for PCK are knowledge of representations of the specific content and instructional strategies on the one hand, and understanding of learning difficulties and students' conceptions of specific content on the other. PCK involves the combination of content and appropriate pedagogy to understand how topics and issues are organized, represented and adapted to the diverse interests and abilities of learners for effective instruction (Shulman, 1987).

PCK has been widely used as a model for investigating of knowledge of teachers. PCK is related to the planning and instruction in the classroom and it forms part of professional knowledge base of teachers (Fernandez, 2014). Shulman stated that teachers' knowledge includes seven categories: a. content knowledge, b. general pedagogical knowledge, c. curriculum knowledge, d. pedagogical content knowledge, e. knowledge of learners and their characteristics, f. knowledge of educational contexts, g. knowledge of educational ends, purposes, and values, and their philosophical and historical grounds.

Shulman emphasized pedagogical content knowledge as a "distinct body of knowledge for teaching which represents the blending of content and pedagogy into understanding how particular topics, problems or issues are organized, represented and adapted to the diverse interests and abilities of the learners and presented for instruction" (p.8). According to Shulman, PCK includes an understanding of what makes the learning of specific topics easy or difficult, the preconceptions that students bring to the classroom and the knowledge of the strategies teachers use to deal with misconceptions.

Curriculum knowledge is represented by the programmes designed for the teaching of a particular subject and topics at a given level of education, the variety of instructional materials available in relation to those programmes and characteristics that guides the use of those materials (Shulman, 1986). Magnusson, et. al (1999) stated that science curriculum knowledge consists of two categories: mandated goals and objectives, and specific curricular programmes and materials. While Shulman considered curricular knowledge to be a separate domain of the knowledge base for teaching (Wilson, Shulman, & Richert, 1988). Grossman (1990) asserted that it is part of pedagogical content knowledge because it represents knowledge that distinguishes the content specialist from the teacher which is stressed by pedagogical content knowledge.

Furthermore, the curriculum and its associated materials and pedagogy from which the teacher draws tools for teaching a particular content and assessment of the students' performance represents teacher curriculum knowledge (Shulman, 1986). This implies that, teachers need to possess understanding about the curriculum available for instruction, understand well the materials for that instruction, understand the pedagogical approaches and their alternative forms in dealing with misconceptions and varied abilities in the classroom. Another aspect of teachers' curriculum knowledge deals with knowledge of alternative curriculum materials, knowledge of students as well as knowledge of the content of the curriculum materials (Shulman, 1986).

According to Shulman, when teachers possess adequate curriculum knowledge, of content structure of the subject matter and specific pedagogical approaches associated with the subject matter, they tend to be more effective in their teaching. This implies that, adequate curriculum knowledge of natural science teachers will have positive effect on their classroom instructional practices.

Teachers' sense of efficacy belief is derived from Bandura's (1986) social cognitive theory. Self-efficacy is the belief in one's capabilities to deal with different situations and perform specific tasks required to produce a given outcome (Bandura, 1997). The construct of self-efficacy is the generalized behavior based on two factors: personal efficacy and outcome expectancy. Personal efficacy belief is the judgement of one's belief in his/her capability and competency to succeed in a given task while outcome efficacy deals with an individual's judgement about a performance to be realized in a given task based on personal experiences.

Self-efficacy belief is a person's belief about his/her ability to organize and execute a certain task. Self-efficacy is not fundamentally a function of individuals' skills but rather the product of individual judgments about what could be done using one's own ability. In other words, self-efficacy is a person's judgment about his/her ability to successfully undertake a particular activity (Dede, 2008). Therefore self-efficacy is the belief in one's capabilities to deal with different situations and to perform a given task that is required to achieve a certain target or goal and this belief is dependent on individual's belief in his abilities. According to Bandura (1986), instructional approach may be predicted by investigating self-efficacy using both types of expectancy determinants. He hypothesizes that people having both high outcome expectancy and personal efficacy will behave in an assured, decided manner and persist on task. On the other hand, people with both low outcome expectancy and high personal efficacy temporarily intensify their efforts, but eventually are frustrated.

The focus of this study is on natural science teachers' self-efficacy beliefs, curriculum knowledge and classroom instructional practices. This is because self-efficacy beliefs play a role in determining how teachers approach their teaching while curriculum knowledge also determines the quality of the teacher's instructional and assessment practices. Therefore, effective interaction of natural science teachers' efficacy beliefs and their curriculum knowledge is likely to impact on the teachers' classroom instructional and assessment practices.

2.2 Related Literature

2.2.1 Self-Efficacy Beliefs

Self-efficacy belief as a psychological construct is rooted in the social learning theory developed by Bandura (1977, 1986). Bandura (1986, p.122) defines Self-efficacy beliefs as “judgments of how well one can execute courses of action required to deal with prospective situations”.

Bandura (1986) suggested that behavior is based on two factors,

1. Firstly, an individual develops a generalized expectancy about action outcome contingencies based upon life experiences. This is referred to as outcome expectancy, and
2. Secondly he/she develops specific beliefs about his/her own ability to cope. This is also called self-efficacy.

Gibson and Dembo (1984) identified two teacher efficacy dimensions and developed a 30-item the Teacher Efficacy Scale (TES) to assess these two dimensions of efficacy.

a. Personal Teaching Efficacy (PTE): This includes teacher beliefs on their knowledge of suitable teaching techniques, ability to help students learn, achieve more, do better than usual and increase retention among other skills (this is equivalent to self-efficacy).

b. General Teaching Efficacy (GTE): This is based on the belief that the teacher’s influence on students is limited by external factors, such as home and family background (which is equivalent to Bandura’s factor of outcome expectancy).

According to Gibson and Dembo (1984), teachers who have high scores on both teaching efficacy and personal teaching efficacy would be active and assured in their responses to students and these teachers persist longer, provide a greater academic focus in the classroom and exhibit different types of feedback. On the other hand, teachers who have low scores on both teaching and personal efficacy were expected to give up easily if the results they get were not satisfactory.

Personal teaching efficacy (PTE) was related to practical lessons, teacher's willingness to try a variety of materials and instructional approaches, the desire to find better ways of teaching, and implementation of progressive and innovative teaching methods. The level of organization, planning, and fairness a teacher displayed, as well as clarity and enthusiasm in teaching (Allinder, 1994; Tschannen-Moran & Hoy, 2001).This means the Gibson and Dembo instrument suggest that teacher efficacy influences teachers' classroom practices, their openness to new innovations, and their attitudes toward teaching. Also, teacher efficacy influences student achievement and attitude while school structure and organizational climate appear to play a role in shaping teachers' sense of efficacy.

Enochs and Riggs (1990) also developed a subject matter instrument which was Science Teaching Efficacy Belief Instrument (STEBI) to measure efficacy for teaching science. The STEBI has two versions; the Science Teaching Efficacy Belief Instrument form A (STEBI-A) for in-service elementary teachers and the Science Teaching Efficacy Belief Instrument form B (STEBI-B) for pre-service elementary teachers. This instrument was based on the Gibson's and Dembo's instrument (TES) and also consisted of two largely uncorrelated subscales: Personal Science Teaching Efficacy (PSTE) and Science Teaching Outcome Expectancy (STOE). In most applications, the STEBI consists of 25 items with a 5-point Likert-type scale.

As measured by the STEBI, teachers who have a high sense of personal science teaching efficacy reported spending more time teaching science and developing the science concept being considered (Riggs & Jesunathadas, 1993). On the other hand, teachers with low personal science teaching efficacy (PSTE) spent less time teaching science, used a text-based approach, were rated weak by site observers such as the circuit supervisors, made fewer positive changes in their beliefs about how children learn science, and were less likely to choose to teach science (Riggs, 1995). This suggest that, teachers with high-efficacy engaged in quality of teaching in science whiles those with low scores on science teaching outcome expectancy (STOE) were rated as less effective in science teaching, rated themselves as average and were rated as poor in attitude by circuit supervisors (Enochs, Scharmann & Riggs, 1995). Tobin, Tipin and Gallard (1994) also found that, teachers' sense of self-efficacy is associated with successful teaching. In this study, the Science Teaching Efficacy Belief Instrument (STEBI-A) for in-service teachers was adapted to measure natural science teachers' self-efficacy belief regarding natural science teaching. This instrument was appropriate because the instrument is subject specific (Science) and also, the STEBI-A can be used for measure the level of self-efficacy belief of in-service natural science teachers in the Gomoa East District of the Central Region of Ghana.

According to Tschannen-Moran and Woolfolk-Hoy (2001), teachers' efficacy belief plays a key role in their performance and motivation. According to them, teachers with high sense of efficacy will work hard, adapt to innovations, apply effective classroom management strategies as well as spend more time on the subject and also encourage students' autonomy.

Studies have shown that teachers' efficacy beliefs are related to effectiveness, student motivation, adoption of curriculum innovations and child-centred instructional approaches (Ngman-Wara & Edem, 2016; Woolfolk &Hoy, 2000). This means that, high efficacy belief of teachers generally results in to quality teaching. Also, teachers with high efficacy are more likely to divide the class for small group instruction as opposed to instructing the class as a whole (Sarikaya, 2004). Researchers found that there was a significant relationship between efficacy and student achievement (Ross, 1992; Watson, 1991). Teacher efficacy also plays a role in shaping students' attitudes toward school, the subject matter being taught, and even the teacher. Other studies show that the stronger the teaching efficacy of a teacher, the greater a student's interest in school and the more students perceived that what they were learning was important. Students of teachers with a stronger sense of personal efficacy gave more positive evaluations of the teacher (Woolfolk &Hoy, 2000). Additionally, Allinder (1994) found that teaching efficacy was related to instructional experimentation and willingness to try a variety of materials and approaches, the desire to find better ways of teaching, and implementation of progressive and innovative methods.

In the views of Pierro (2015), teacher self-efficacy is a critical piece in terms of understanding why teachers may not want to engage their pupils in science inquiry and hands-on activities. Pierro found that teachers having high sense of efficacy engaged their pupils in hands-on and inquiry-based science instruction. Similarly, Czerniak (1990) found that teachers with a high level of self-efficacy adopt investigative and child-centered instructional strategies while the teachers with a low level of self-efficacy generally adopt teacher-centered strategies. Since lower primary school pupils need to be guided to create their own knowledge through inquiry or scaffolding interactions between teacher and child (DeJarnette, 2012), it is important to study the level of the efficacy beliefs of the teachers.

Research shows that persons who possess a high degree of self-efficacy are more willing to undertake difficult tasks, to persist longer at them, and to spend more effort in the process (Witt-Rose, 2003). On the other hand, a person with low self-efficacy beliefs may give up on the same problem because he or she thinks it is beyond his or her capability (Allen, 2010). This means that self-efficacy is an important elements of an effective teaching because teachers' self-efficacy has been associated with student motivation, teachers' adoption of innovations, and teachers' competence as rated by superintendents, effective classroom management strategies of the teacher, instructional approaches, time spent on different subjects, and teachers' referrals of students to special education (Woolfolk & Hoy, 2000). Chan (2003) argues that teachers with a strong sense of self-efficacy experience less stress and are more successful in creating an effective teaching and learning environment as well as ensuring students success. Conversely, teachers with low self-efficacy do not feel personally responsibility for the failure of students, and want to be the sole authority in their classroom thus adopting teacher centred approach to teaching (Garrett, 2008). The use of teacher centred approach and authoritarian classroom teacher behavior has been found to be ineffective in ensuring students learning. This gives credence to the fact that it is important to study the efficacy beliefs of in-service teachers who are implementing new curriculum innovation such as the Ghanaian natural science curriculum introduced in 2007 by the Curriculum Research and Development Division (CRDD) of the Ghana Education Service (G.E.S). This will help to determine how teachers are implementing the curriculum.

In summary, research has shown that teacher efficacy has positive effect on teacher effort and persistence in the face of difficulties (Sarikaya, 2004; Gibson & Dembo, 1984); implementing of new instructional practices and adoption of innovations (Evers, Brouwers, & Tomic cited in Gavora, 2011) as well as on pupils' academic achievement and success (Ross, 1992; Caprara, Barbaranelli, Steca & Malone, 2006). Furthermore, literature shows that teachers with high levels of self-efficacy regularly experiment with new teaching approaches, are critical of their students, are generally instructionally and emotionally more supportive, spend more time with problematic pupils, are usually more enthusiastic and are usually more committed to the profession than other teachers (Ashton & Webb, 1986; Tschannen-Moran & Woolfolk Hoy, 2007). Also, teachers with high level of efficacy deal with the needs of low-ability students (Ross & Gray, 2006), exhibit greater levels of instructional planning (Allinder, 1994) and use less teacher-directed whole-class instruction (Ashton & Webb, 1986)

2.2.2 Teachers' self- Efficacy Beliefs towards science teaching

The concept of self-efficacy in science teaching recently has become the focus of many studies (Morgil, Secken & Yucel, 2004), and it is regarded as one of the most fundamental elements for an effective teaching in science classrooms. Henson (2001) in a study observed that science teachers who have high levels of self-efficacy were more effective classroom teachers. According to Sarikaya (2004), teachers with a higher sense of efficacy were more likely to criticize a student when he/she gives incorrect response and also more likely to persist with a student in a failure situation. High efficacy teachers were also found to be more likely to divide the class for small group instruction as opposed to instructing the class as a whole. In contrast to this, teachers with low self-efficacy do not feel personally responsible for the failure of students, and want to be the sole authority in their classroom (Sarikaya, 2004).

There have been several studies on self-efficacy beliefs of both pre-service and in-service teachers, for instance, the comparison of self-efficacy beliefs of pre-service teachers in different countries (Cakiroglu, Cakiroglu & Boone, 2005), and the relationship between inservice teachers' self-efficacy and their perceived job performance (Khurshid, Qasmi & Ashraf, 2012). Also, one of the most widely studied topics related to self-efficacy of pre-service teachers is the factors influencing self-efficacy beliefs (Azar, 2010; Yalcin, 2011). However, these studies seem to focus less on how teacher curriculum knowledge influences self-efficacy beliefs of in-service teachers and whether science teachers' self-efficacy beliefs have any effect on the implementation of curriculum innovations. In this study, attempt is made to establish how natural science teachers' curriculum knowledge and self-efficacy beliefs influence their implementation of natural science curriculum, an innovation in the Ghanaian science education, through their classroom instructional practices.

Gavora (2011) found that in-service science teachers showed an above-average level of perceived teacher self-efficacy and high teaching efficacy beliefs. Ngman-Wara (2012) conducted a study with a sample of 210 pre-service secondary science teachers enrolled in various science education programmes in the Department of Science Education, University of Education, Winneba during the second semester of the 2010/2011 academic year. He reported that, pre-service secondary science teachers' self-efficacy beliefs regarding science teaching were generally very high for both PSTE and STOE. He also found that, males had higher self-efficacy than females for STOE while females had higher PSTE than males. Ngman-Wara and Edem (2016) also found out that, pre-service basic school science teachers exhibited very high self-efficacy beliefs towards science teaching on both PSTE and STOE.

Czerniak cited in Azar (2010) found that inservice science teachers with a high level of self-efficacy beliefs adopt investigative and student-centered strategies while the teachers with a low level of self-efficacy generally adopt teacher-centered strategies. Leckhu (2013) found that in-service secondary school teachers' had a high positive sense of efficacy beliefs in teaching Physical Science. Antwi, Anderson and Abagali (2016) conducted a study with a sample 46 JHS science teachers in Kassena Nankana Municipal, in the Upper East Region of Ghana. They reported that that science teachers had initial moderate self-efficacy beliefs but developed high self-efficacy beliefs after in-service training was conducted for them. The changes teachers need to go through in implementing curriculum innovation requires that, they have high sense of efficacy beliefs. Isler and Cakiroglu (2009) found that, primary school teachers possessed high self-efficacy beliefs in the implementation of curriculum. They also found that, teachers become more efficacious when they implement the curriculum for a longer period of time. Wilson and Cooney (2002) also found that, teachers who focus more on the requirements of the curriculum tend to be more efficacious that teachers who focus more on examination. Kabaoglu (2015) found that, there existed a positive and statistically significant relationship between curriculum implementation and teacher self-efficacy beliefs. In other words, the degree of curriculum implementation increases as teachers' self-efficacy beliefs increases and vice versa.

It seems no studies has been conducted on Ghanaian in-service primary school teachers' self-efficacy beliefs regarding natural science teaching. This study is therefore an attempt to investigate the level of self-efficacy beliefs among primary school regarding natural science teaching in Gomoa East District of the Central region of Ghana.

2.2.2.1 Science Teachers' Curriculum Knowledge

The word curriculum is derived from the Latin word "curere" which is literally translated as race course (Connelly & Clandinin, 1988). According to Adentwi (2005), this metaphoric description of curriculum suggests that learners in schools or training institutions consider their courses as series of obstacles or hurdles to be cleared. Curriculum authorities have proposed a number of definitions each of which makes the learner view the concept from different perspectives. In his definition, Hirst (1968) sees curriculum as "a programme of activities designed so that pupils will attain, as far as possible, certain educational ends or objectives" (p.40). This description reminds us of the fact that the curriculum of an institution is made up of all the activities that have been planned for pupils for the attainment of specific educational objectives. Tyler (1969) defines curriculum as a plan for action or a written document that includes strategies for achieving desired goals or ends. Similarly, Wheeler (1983) states that curriculum is the planned experiences offered to the learners under the guidance of the school. This means a curriculum usually contains a statement of aims and specific objectives, indicates selection and organization of content, show certain patterns of learning and teaching finally it includes a programme of evaluation of the outcomes. Taba (1962) posit that "Curriculum is after all, a way of preparing young people to participate as productive members of our culture" (p.10). Here the purpose is to provide the young generation with whatever knowledge, skills, attitudes and values that will enable them play the various roles that are demanded of them by the culture into which they are born.

A cursory look at the above descriptions or definitions show that the curriculum may be viewed as either a process or something static. The activities that are carried out at the stages of its development and those at the stages of its implementation as well as evaluation constitute its process. In its static form, the curriculum is the documented stages of its development implementation and evaluation. According to Alexander (2009), the curriculum is the key reference point for teachers, particularly in a developing country like Ghana, where it is encoded in the official textbook and teacher guides. Teachers' pedagogic approaches, strategies and practices thus serve to enact the curriculum.

Teaching is a complex activity which draw on different kinds of knowledge. Shulman (1986) stated that curriculum knowledge deals with the interplay of content knowledge, general pedagogical knowledge, curricular knowledge, pedagogical content knowledge and knowledge of learners as well as knowledge of educational ends and purposes. The Ghanaian Natural Science teachers' curriculum knowledge includes knowledge about goals, objectives, content, learning materials, teaching methods and forms of assessment.

Curriculum knowledge is an important part of a teachers' overall pedagogical repertoire and plays a crucial role in how the teacher translates the intended curriculum into practical classroom teaching. This takes place as the learner acquires the planned or intended experiences, knowledge, skills, ideas and attitudes that are aimed at enabling the same learner to function effectively in a society (Connelly & Clandinin cited in Ntumi, 2016). Ntumi (2016) revealed that, challenges such as inadequate teaching and learning materials, inadequate in-service training, lack of parental involvement and inadequate teachers' knowledge in the curriculum serves as impediment for successful curriculum implementation.

Since the natural science curriculum is a new curriculum innovation introduced into the education system in 2007, it is important to study teachers' knowledge of all aspect of the curriculum. As stated elsewhere, in-service teachers may face a number of problems in implementing curriculum innovations. They may not be conversant with the natural science curriculum content and demands if they are not well briefed on it before its implementation. They may be required to learn the contents and shift from their old ways of teaching to the new instructional approaches of the new curriculum. It is therefore important for in-service teachers to be conversant with the curriculum content, pedagogy, objectives and assessment strategies.

2.2.2.2 Science teachers' content knowledge

Shulman (1986) defines content knowledge as the amount of subject matter knowledge in the mind of the teacher. According to Shulman, content knowledge goes beyond knowledge about facts and concepts. It comprises knowledge of the structures of the subject and variety of ways in which the basic concepts and principles of the subject are organized. Thus, the teacher must understand the variety of ways of organizing the subject. "The teacher needs not only understand that something is so; the teacher must further understand why it is so, on what grounds its warrant can be asserted, and under what circumstances our belief in its justification can be weakened and even denied" (Shulman, 1986, p.9).

Magnusson, Krajcik and Borko (1999) posits that Knowledge of specific curricular programme as a category of teachers' knowledge of curriculum consists of knowledge of the programmes and materials that are relevant to teaching a particular domain of science and specific topics within that domain. This means that, natural science teachers should be knowledgeable about the content of the natural science curriculum content as well as the activities and materials to be used in teaching those contents (Magnusson, Krajcik & Borko, 1999). They further indicated that knowledge of requirements for learning consists of "science teachers' knowledge and beliefs about prerequisite knowledge for learning specific scientific knowledge, as well as their understanding of variations in students' approaches to learning as they relate to the development of knowledge within specific topic areas" (p. 10). Teacher knowledge of prerequisite knowledge required for students to learn specific concepts includes knowledge of the abilities and skills that students might need to successfully learn specific subjects or topics.

Diamond, Maerten-Rivera, Rohrer and Lee (2013) suggest that teacher CK can have a direct effect on student learning and indirect effect on PCK. Studies however suggest that elementary school teachers tend to have major gaps in their Science curriculum Content Knowledge (SCK) and that these gaps are a major obstacle to effective teaching (Nowicki, Sullivan-Watts, Shim, Young, & Pockalny, 2013). This is largely as a result of poor science preparation in pre-service teacher programmes

(Diamond et, al, 2013) and inadequate in-service training for practicing teachers (Leu & Ginsburg, 2011). Kahan, Cooper and Bethea (2003) stated that researchers frequently conclude that students' would learn more science if their teachers knew more science. However, "content knowledge in the subject area alone does not suffice for good teaching" (p.223). Though, Kallery and Psillos (2001) found that teachers' content knowledge influenced the way in which they represented the content to students.

Researchers have established that teachers may feel uncomfortable teaching science to children due to their lack of content and pedagogical knowledge. This would hinder their ability and motivation to create meaningful science experiences for children (Watters, Diezmann, Grieshaber, & Davis, 2001; Fayez, Sabah, & Oliemat, 2011). Garbett (2003) and Hedges (2003) suggest that it is essential for teachers to develop vast science content knowledge base to support children's scientific thinking. Hedges and Cullen (2005) highlight that, "teachers having sufficient breadth and depth of content knowledge are able to respond meaningfully to extend children's interests and inquiries" (p. 20). They stated that it is "likely that teachers' beliefs and their lack of content knowledge will impact on the curriculum provided for children and on the teachers' ability to effectively construct knowledge with children" (p. 16).

Some studies have highlighted the prevalence of teachers' misconceptions of both in-service and pre-service teachers and the potential negative impact of this on their teaching of the often complex, scientific ideas in school examining the science subject knowledge (Garbett, 2003; Liston, 2013). A study conducted by Garbett (2003) revealed that pre-service teachers' content knowledge in science was generally poor. Also, it has been shown that high percentages of pre-service teachers enter the teaching profession with similarly inaccurate conceptions of science (Murphy & Smith, 2012; Liston, 2013).

According to Tekkaya, Cakıroglu and Ozkan (2004), even though pre-service primary teachers often feel confident in their teaching of science, they can have poor knowledge and understanding of scientific concepts. Khwaja (2002) found that weak content knowledge contributes to low self-efficacy and poor pedagogical skills. This implies that, teacher's self-efficacy can become undermined and this can cause them to avoid teaching science, or to do so in more instructional ways (e.g., using a textbook, placing heavy reliance on kits and worksheets, avoiding practical work and depending on the assistance of external experts) (Grossman, Wilson & Shulman, 1989). Primary teachers' inadequate content knowledge and understanding of science therefore may affect their teaching methodologies and their ability to teach science effectively (Murphy & Smith, 2012; Harlen, 2013). Appiah (2015) found that majority of JHS teachers had inadequate science curriculum content knowledge and also admitted they encountered some difficulties when teaching some topics in science. He also found that, JHS teachers with mostly quoted information from books verbatim. This may be due to low subject matter knowledge.

Research on teacher content knowledge indicates that teacher's knowledge of subject content influences the teacher's instructional practices across subject areas and at different grade levels (Brophy, 1998; Lee, 1995; Shulman, 2000). In contrast, teachers with inadequate content knowledge rely heavily on the textbook as the primary source of subject matter content (Feiman-Nemser, 2001) and tend to minimize students participation in a class discussion. This means that teachers' content knowledge and pedagogy shape how the teacher might respond to students' questions and inquiries as the lesson unfolds in the science classroom (Crawford, 2007). Also, if the teachers' knowledge of other curricular demands are inadequate to meet the new content associated with curriculum innovations, then they may be reluctant to implement it (Ngman-Wara, 2011). Therefore, in order to ensure successful implementation of the natural science which is a curriculum innovation in Ghana, there is a need to consider factors such as curriculum knowledge of the natural science teacher.

2.2.2.3 Science teachers' pedagogical knowledge

Shulman (1986) defines pedagogical knowledge as knowledge of generic principles of teaching and classroom organization. According to Shulman, pedagogical knowledge is a major category of teacher knowledge together with content knowledge. Voss (2014) also defined general pedagogical knowledge as the knowledge needed to create and optimize teaching–learning situations across subjects, including declarative and procedural knowledge of the following domains; (a) Knowledge of classroom processes: Knowledge of classroom management, knowledge of teaching methods and their effective organization, knowledge of classroom assessment and (b) Knowledge of student heterogeneity: Knowledge of students' learning processes and knowledge of individual student characteristics and the specific challenges they present in the classroom.

Koehler and Mishra (2008) asserted that pedagogical knowledge (PK) is the deep knowledge about the methods of teaching and learning and how it encompasses the overall educational purposes, values, and aims. It is therefore the knowledge of all issues of student learning, classroom management, lesson preparation and implementation, and student evaluation. Thus, pedagogical knowledge includes knowledge about techniques or methods to be used in the classroom; the nature of the target audience; and strategies for evaluating student understanding. A teacher with deep pedagogical knowledge understands how students construct knowledge, acquire skills, and develop habits of mind and positive dispositions toward learning (Koehler & Mishra, 2008). As such, pedagogical knowledge requires an understanding of cognitive, social, and developmental theories of learning and how they apply to students in their classroom.

The science classroom is typically made up of pupils with diverse abilities and needs which constitute a complex social framework within which learning takes place. These complex abilities and diverse need of pupils in the classroom pose various challenges to teachers, who have to know how to structure and orchestrate learning opportunities accordingly. Also, pupils' learning outcomes are determined largely by the characteristics of individual students in terms of the differences in their prior knowledge and preconceptions as well as in their motivational orientations. Science teachers need knowledge of how these diversity in the classroom can be properly handled to ensure insightful learning of pupils (Voss, 2014).

Grossman (1990) stated refers to teachers' knowledge and beliefs about the purposes and goals for teaching science at a particular grade level as orientation towards science teaching and indicated that this orientation represents a general way of viewing or conceptualizing science teaching. According to Borko and Putnam (1996), these knowledge and beliefs serve as a "conceptual map" that guides instructional decisions about issues such as daily objectives, the content of student assignments, the use of textbooks and other curricular materials, and the evaluation of student learning.

Teachers should know how to teach their students by focusing on subject matter, content, and incorporated pedagogy to achieve classroom objectives. This means a transformation of teachers' knowledge from a variety of domains of knowledge, which includes subject matter knowledge, pedagogical knowledge, and knowledge about content of the curriculum (Botha & Reddy, 2011). There is a need for natural science teachers to combine knowledge in content and pedagogy to effectively teach natural science in their classrooms. Natural science teachers' general content knowledge, pedagogical knowledge, knowledge of curriculum materials as well as knowledge of aims and objectives of the natural science curriculum are crucial aspect of implementing the natural science curriculum. Therefore, for effective implementation of the 2007 natural science curriculum, there is a need to examine how the interplay of these aspects of the teachers' knowledge affects their classroom instructional practices. This is because, as stated by Nuangchalerm (2011), PCK involves knowing which teaching approaches best fit a particular content and how elements of the content can be arranged for an effective science teaching.

In education of young children as is the case with lower primary school pupils, it has been postulated that in order to effectively provide science instruction to young children, teachers must have Pedagogical Science Knowledge (PSK) (Chalufour, 2010). According to Chalufour, PSK is the understanding of science content, expertise of how children acquire new knowledge, and the abilities required to facilitate and support children's opportunities to learn new knowledge in science through inquiry and conceptual development. This type of pedagogy allows teachers to offer science curriculum that aligns with children's natural curiosity of the world around them and focuses their early science skills, which is the path to science literacy and the beginning of critical thinking.

There are studies that attempted to directly study teachers' knowledge of science curriculum. For example, Voss (2014) and Nuangchalerm (2011) found that knowledge of curriculum was an essential component of pre-service teachers' pedagogical reasoning around lesson planning and instruction. Also there is a limited study of teachers' existing science curriculum knowledge and its relationship to planning and instruction (Abell & Lederman, 2007). The teacher's activities in the classroom comes from the decisions taken during both the planning and implementation (Voss, 2014). These decisions depend on the teacher's knowledge in pedagogical strategy and content knowledge, curriculum knowledge, knowledge of the students' understanding of the topic and knowledge of specific methods suiting the cognitive goals to be achieved.

The Ghanaian natural science curriculum requires the teacher to carefully study the syllabus and plan ahead the activities the pupils will carry out during particular periods (CRDD, 2012). Natural science teachers' curricular knowledge is an important factor influencing the methods a teacher selects prior to instruction and assessment.

2.2.2.4 Teachers' knowledge of goals and objectives of science curriculum

According to Magnusson, Krajcik and Borko (1999), an important category of the curricular knowledge component of pedagogical content knowledge includes "teachers' knowledge of the goals and objectives for students in the subject(s) they are teaching, as well as the articulation of those guidelines across topics addressed during the school year" (p.9). It also includes the knowledge teachers have about the spiral curriculum in their subject(s). That is, what pupils have learnt in previous years and what they are expected to learn in later years (Grossman cited in Magnusson, Krajcik & Borko, 1999). Schools have documents such as syllabus that indicate, for specific subjects, what concepts are to be addressed to meet national goals. Effective science teachers should be knowledgeable about these documents (syllabus) as well as the goals and objectives of the natural science (Magnusson, Krajcik & Borko, 1999).

2.2.2 5 Teachers Knowledge of assessment in science curriculum

Knowledge of assessment in science has been seen as a component of pedagogical content knowledge, which was originally proposed by Tamir (1988) as teachers' knowledge of the aspects of students' learning that are important to assess within a particular unit of study and knowledge of the methods by which that learning can be assessed. This means that teachers need to be knowledgeable in new assessment methods such as performance-based assessments and portfolios (e.g, Abell, & Lederman, 2007; Duschl & Gitomer, 1997), written laboratory reports, and artifacts such as drawings, working models, or multi-media documents (Vingsle, 2014).

“Teachers’ knowledge of methods of assessment includes knowledge of specific instruments or procedures, approaches or activities that can be used during a particular unit of study to assess important dimensions of science learning, as well as the advantages and disadvantages associated with employing a particular assessment device or technique” (Magnusson, Krajcik & Borko, 1999, p.15).

2.2.2.6 Factors that influence teachers’ curriculum knowledge

According to Harris and Sass (2011), years of teaching experience in the classroom was the only teacher factor found to improve teachers’ curriculum content knowledge and student learning. However, Ngman-Wara (2015) found that no statistically significant relationship exists between science teachers’ years of teaching experience and their knowledge of contextualized science instruction. Other studies emphasized that, curriculum knowledge was influenced by practice and experience (Marton, 2014; Marton & Pang, 2006). Also, according to Van Driel and Berry (2012), content knowledge can be strengthened through teaching experience, professional development and teacher collaboration. Ngman-Wara (2015) found that only professional qualification had a positive and statistically significant correlation with teachers’ knowledge of contextualized science instruction. The more experience the teachers gather in the classroom, the more the teachers get acquainted with the curriculum and also professional development programmes add to the teachers’ curriculum knowledge base. This implies that professional qualification and continuous professional development as well as years of teaching may have influence on teachers' content knowledge of the natural science curriculum.

2.3.1 Science teachers' classroom instructional practices

The natural science curriculum emphasize inquiry processes of science instruction. Inquiry based instruction is defined by National Research Council (NRC, 2012) as a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in the light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, predictions and communicating the results. It has therefore been suggested in the syllabus that, pupils who have studied the environmental studies should have good observational skills and communication skills as a pre-requisite for effective studies of natural science (CRDD, 2007).

According to TIMMS (2011), one of the ways in which students have been encouraged to build upon their knowledge and understanding of science is through the process of scientific inquiry, and the contemporary science curricula of many countries place considerable emphasis on engaging students in this process. In the view of Shank (2006), inquiry-based instruction with authentic questions generated from student's experiences is the central strategy for teaching science at the basic schools. This approach is consistent with the constructivists' view that learning is a process of building structures of experience where prior knowledge and experiences add to new understandings (Shank, 2006). For students to grasp inquiry concepts, teachers need to use inquiry-based science pedagogies and provide multi-investigational opportunities for students to do science (Barrow, 2006) as suggested by the natural science curriculum. Hundeland (2011) found that teachers who are positive towards elements of inquiry in their teaching provided opportunity for students to work together in groups.

Natural science teachers must select instructional practices in the classroom that promote inquiry-based instruction and critical thinking. Instructional approaches should assist pupils to be able to critically understand, assess, and make decisions based on the things in their natural environment and which are relevant to their lives. In a study to investigate science teachers' ability to organise classroom interaction to ensure full and meaningful participation by most pupils. Osei (2004) reported that few opportunities were provided for learners to develop individual prowess of expression, to think for themselves and to debate with other pupils.

Teachers' curriculum knowledge and self-efficacy belief help them to understand how natural science teachers function in the teaching-learning process, more specifically, how teachers apply their knowledge in making decisions about lesson preparation, presentation, or making on the spot judgment in the classroom. Instructional practices in natural science can either be teacher-centred instruction or child-centred instruction. For the purpose of this study, these two instructional practices are discussed briefly.

2.3.2 Child-Centred Instruction

Child-centred instruction [CCI] is an instructional approach in which children's characteristics influence the content, activities, materials, and pace of learning. The teachers should avoid teacher-centred teaching methods and rather emphasize activity-oriented teaching and learning (CRDD, 2007). The natural science syllabus and textbooks therefore has a range of child-centred interactive and activity-oriented methods. Some of these are: group work, demonstrations by pupils, class discussions, role-play, fieldtrips, nature walk, and project work. These are science instructional learning practices which involve making science content real to pupils and also helps pupils develops their own ideas about science (Shamsid-Deed, & Smith, 2006). The teacher provides pupils with opportunities to learn independently and from one another and coaches them in the skills they need to do so effectively and this places the learner at the centre of the learning process (Collins & O'Brien, 2003). According to Garret (2008), the instructional goal in child–centered classrooms are based on constructivist principles of learning which is to create a learning environment where knowledge is co-constructed by the teacher and students rather than transmitted directly by the teacher.

In CCI, the child assumes a certain degree of responsibility for what is taught and how it is learned. There is a shift from the traditional methods of instruction to activity-based instruction where the pupils have a greater degree of participation in the learning process. The National Research Council (2012) of the United States of America recommended organizing learning environments around four foci: knowledge-centred, learner-centred, assessment-centred, and community-centred. The knowledge-centred learning approaches came out of research on novices and experts that has revealed that experts have organized their knowledge very differently than novices. So knowledge-centred learning stresses learners developing their own knowledge to facilitate transfer of their learning to new contexts and application of their learning to open-ended challenges such as problem-solving, critical thinking, and design. Similarly, the Natural science curriculum of Ghana recommends that teachers should help pupils to learn to compare, classify, analyse, look for patterns, spot relationships and draw their own conclusions (CRDD, 2007).

Whistler and McCombs (1997) stated that in a learner-centred learning environment, learners are treated as co-creators in the learning process, as individuals with ideas and issues that deserve attention and consideration. Learner-centred learning environments recognize that the prior knowledge of learners powerfully influences future learning and thus attempt to build on prior knowledge.

Studies show positive influence of student-centred learning approaches to teaching on pupils' academic performance, attitudes toward learning, and persistence in their studies (NES, 2011). Despite basic school teachers' positive view about the effectiveness of learner-centred instructional approaches on pupils' academic achievement and positive attitude towards science teaching and learning, they have limited use of the approaches in their classrooms (Ngman-Wara, 2011). A number of reasons are given for this limited use of these approaches. Teachers have concerns about the amount of content that can be covered using child-centered approaches (Tien, 2011). Ghanaian Junior High School Integrated science teachers pointed out that they would be unable to adequately prepare their pupils for the final Basic Education certificate Examination (B.E.C.E) if they were to use learner-centred approaches in their science lessons (Ngman-Wara, 2011). Content coverage is therefore a high priority for teachers, more especially Ghanaian science teachers. As to whether science teacher can cover the same or more content with child- centred learning approaches as can be covered with traditional lecture-based approaches depend on individual teachers (Osei, 2004). Osei indicated that some Ghanaian science teachers indicated that they covered as much content or most content with child-centred learning approaches while some adopters of child-centred learning approaches indicated that they now covered less content than when they exclusively lectured, but that students were learning more.

Achuonye (2015) found that innovative methods such as inquiry, problem-based learning, and contextual methods are least used or never used by primary and secondary school science teachers even though these are the research-proven strategies that enhance learner centeredness and active, deep learning which promote creativity, higher cognitive skills, self-directed, and lifelong learning that are very much needed in every functional education (Biggs, 1999; Bybee, 2006; Day & Williams, 2000; Miller & Snlbecker, 2000). Yet, Appiah (2015) found that JHS teachers did not use hands-on activities in their lessons and did not encourage pupils to explain concepts in their own words.

UNICEF (2014) indicated that pupils should be made to understand the purpose of the lessons and activities in order to motivate them to learn. In implementing child-centered instructional approach, it is important that teachers link what is taught and how it is taught to the daily lives of the children. Teachers should therefore make an effort to connect with their pupils, know what is important for them and create a relaxed atmosphere in which students feel safe to exchange with each other and the teacher. Also, child-centered instruction demands that lessons build on previous knowledge and skills of students and use daily experiences of the children as examples when explaining new concepts (UNICEF, 2014). This can be done when children are encouraged to bring things from home and share their stories and experiences in class.

2.3.3 Teacher - Centred Instruction

Teacher-centred approaches are more traditional in nature, focusing on the teacher as instructor. They are sometimes referred to as direct instruction, deductive teaching or expository teaching, and are typified by the lecture type presentation. In these methods of teaching, the teacher controls what is to be taught and how students are presented with the information that they are to learn. Traditional teacher-centred instruction is generally defined as a style in which the teacher assumes primary responsibility for the communication of knowledge to students (VanDriel & Berry, 2012). Proponents of teacher-centred approach are of the view that teachers command greater expertise about the subject matter and are in the best position to decide the structure and content of any given classroom experience.

Ghanaian science classrooms are generally filled with the dissemination of a relatively fixed body of knowledge that is determined by the teacher (Anamuah-Mensah, Akwesi-Asabere & Mireku, 2004). The teacher elaborates upon a given body of knowledge from his or her own expert perspective rather than building the content of classroom communication around questions that students might have (Voss, 2014). According to Achuonye (2015), traditional teaching methods are characterized by teacher centredness, content-laden, passivity of learners, rote learning, shallow-learning and examination oriented learning. The predominant teacher-centred instructional approach used by Ghanaian science teachers is the lecture method which is also called telling or talk-chalk method. Ajelabi (2000) observed that teacher-centered method is probably the oldest well known and widely used method, still commonly practiced at all levels, and teachers find it very convenient to adopt. Achuonye (2015) also confirmed that teacher-centered instructional approach is still the predominantly used teaching strategy at primary, secondary and tertiary institutions. Achuonye acknowledged that teacher-centred approach is still much on top of the list of teacher's instructional approaches because it covers a large amount of information in a short time.

In summary, instructional practices in science must be carefully chosen for several reasons (Bybee, 2006). Pupils may come to the science classroom with a lot of misconceptions or correct scientific ideas to which the teacher must address. The natural science teacher should choose instructional approaches that recognize misconceptions, correct them, and teach reflective thinking.

2.4.1 Science teachers' classroom assessment practices

Natural science teachers need to understand what pupils know or do not know and therefore need to assess. Assessment is the process of gathering and interpreting evidence of learning to make informed judgments and decisions about how well students are progressing. The National Research Council [NRC] (1999) defines assessment as a process of collecting and interpreting evidence of student progress to inform reasoned judgments about what a student or group of students knows relative to the identified learning goals. It involves the generation, collection, interpretation and communication of data for some purpose (Harlen, 2013). Therefore, assessment is a primary mechanism for feedback on the attainment of standards to pupils and teachers, as well as to parents, the school and the community. In the view of Marriot and Lau (2008) assessment is not just about collecting data, but it is also a process used to appraise students' knowledge, understanding, abilities or skills and it is inextricably linked to a course or programme's intended learning outcomes. From the above, assessment can be summarized as the systematic collection, analysis, and use of information about educational programs undertaken for the purpose of improving student learning and development.

Assessment is a powerful and strong process that can optimize or inhibit learning, depending on how it is undertaken in the classroom. This is why assessment, teaching and learning are said to be inextricably linked, as each informs the other (Calveric, 2010). Researchers estimates that, classroom teachers spend up to about fifty percent of their instructional time on assessment-related activities (Stiggins, as cited in Calveric, 2010). Oduro (2015) found that both formal and informal assessment were practiced by Ghanaian basic school teachers. The formal assessments included class exercises, quizzes, tests, and homework and end-of-year/course examinations whereas; the informal assessments included asking questions orally as well as monitoring of pupils' work during teaching. She further found that teachers used assessment to diagnose pupils' problems. The teachers did not view assessment as just for assigning pupils grades but also, for other purposes as well. For example, assessment results were used as a means of improving teaching. Oduro also indicated that teachers were not using open-ended assessment items in their assessment. Titty (2015) found that primary school teachers were to some extent able to plan their formative assessment. He further indicated that, most teachers did not design desirable classroom assessment instruments which have the potential of promoting critical and logical thinking, problem-solving strategies among others in their pupils.

Natural science teachers' assessment practices therefore entails how the teachers are able to implement all assessment strategies effectively to generate the needed data which will help improve their classroom practices for efficient learning among their pupils. The recommended forms of assessment in the natural science curriculum are formative assessment and summative assessment as well as the School Based Assessment (SBA).

2.4.2 Science teachers practice of formative assessment

Assessment is formative when evidence about students' achievement is elicited, interpreted and used by teachers, learners, or peers to make decisions about the next step in the instructional process (Black & William, 2009). The main use of data in formative assessment is to help in student learning. It is therefore referred to as assessment for learning. The focus is on monitoring student response to and progress with instruction. It provides immediate feedback to both the teacher and student regarding the learning process and therefore forms an integral part of the instructional process as it helps the teacher and students to identify how they are progressing with the lesson and whether they are on course to achieve the objectives of the lesson. It also helps teachers to find out whether students are following the right process to carryout tasks and whether they are using the right skills in the process. Formative assessment can be most directly used at the individual student level because it measures how a particular student is progressing in the instructional process and identifies where support may be needed. Harlen (2013) identifies six key components of formative assessment. These key components help to clearly define how formative assessment should be carried out in science classroom. The six key components are explained below:

In formative assessment, students are engaged to express and communicate their understandings and skills through dialogue, initiated by open-ended and person-centred questions. The teacher creates a classroom culture where students feel free to communicate their understanding and ask questions about concepts being taught and learnt and also about procedures being used. The teacher must ask open-ended questions that will demand students to think deeply about concepts and procedures. Responses from these open-ended and person-centred questions help the teacher to determine how students are thinking about the entire learning process and make the necessary adjustments where necessary. In other words, teachers use questions to generate evidence of students' ideas and to help develop these ideas. Teachers also use feedback from students to regulate their teaching and how students learn. This can be achieved when teachers have clear goals they want students to achieve. The teacher collects evidence when students are involved in investigations, by observing, questioning, listening to how students are using words and studying books.

Students understanding the goals of their work and having a grasp of what is good a quality work:

According to Harlen (2013), the objectives of the lesson are effectively communicated to students by teachers. This makes them aware of what is expected of them in the teaching and learning process. A prerequisite for being able to judge their work is that students understand what they are trying to do, not in terms of what is to be found in terms of the question to be addressed or problem to be solved. Teachers will need to make sure that students understand the purpose and goal of the activity. Stating goals at the start of a lesson is not the only, or necessarily the best, way of conveying them. The understanding of the goals, of why they are working in a particular way can be reinforced by dialogue and questions during the activity and in discussion of what was done and found. If this is done, formative assessment results help them identify how well they are progressing in their achievement of the goals of the lesson and what changes or extra effort they needed to put in place.

Feedback to students that provides advice on how to improve or move forward and avoid making comparisons with other students:

Harlen (2013) explained that in the classroom, teachers provide prompt and effective feedback to students on how they are performing in their learning. A teacher provides oral or written feedback to student discussion or work. For example, a teacher responds orally to a question asked in class; provides written comment in a response or reflective journal, or provides feedback on student work.

Harlen (2013) posits that formative assessment is as much about feedback to teachers as it is about feedback to students. The two are closely related, for how students respond to the questions and feedback from their teacher and from other students is a source of evidence for the teacher to use in making decisions about the next steps for the students. Teachers judge the value of an intervention from the impact of their questioning and other actions, such as gestures and students' facial expressions. Students' feedback informs teachers' decisions about whether to intervene or how to intervene in the course of students' activities. The process is cyclical and each decision changes the situation.

It is worth noting that not all interventions will have the desired positive impact. What happens in classrooms does not always go as planned. The feedback teachers receive from students' reactions enables them to try something different, if necessary, in order to help students to make progress (Harlen, 2013). Sometimes, teachers change plans when students are struggling rather than risk a sense of failure. In this way the feedback enables teachers to regulate teaching to maximize learning. Students are therefore assisted by the teacher through the adoption of other techniques to improve upon their performance. Teachers' guidance of students should be based on certain criteria of what students are required to do and how they are expected to do it based on standards or certain objectives and not necessarily by comparing what students are doing to their peers.

Students are involved in self-assessment so that they take part in identifying what they need to do to improve or move forward. Teachers engage students in assessing themselves based on certain guidelines so as to help them take part in identifying what they need to do to improve their performance. A common goal of formative assessment and Inquiry-based science education is that students become increasingly able to take part in decisions about the quality of their work and develop their understanding of what is involved in learning. Learners are responsible for learning, but whether they take responsibility for it depends on their level of participation in decision making. Students, like all learners, direct their effort more effectively if they know what they are trying to achieve, rather than just knowing what they have to do. Teachers therefore make students aware of what they are expected to achieve and guides them to pause and reflect of whether they are on course in achieving their goals or not.

Dialogue between teacher and students encourages reflection on their learning. Questions play a central role in formative assessment and ensures classroom discourse. Questions asked by the teacher and those asked by students ensure dialogues in the course of the lesson. Questioning takes up a high proportion of teachers' talk and is one of the most important factors in determining students' opportunities for developing understanding through inquiry. It is not the frequency of questions that matters, but their form and content and how they feature in the patterns of classroom discourse. When teachers give activities to students, they move round to check how students are performing and provide guidance where necessary. This also helps student to reflect on their learning.

Stiggins (2002) argues that when teachers use assessment for learning, they provide information for students to advance, rather than merely checking on student learning. However, formative form of assessment is rarely practiced by science teachers in Ghanaian public school (Appiah, 2015). This is because teachers are always in a hurry to complete their syllabus. It is important that teachers use techniques such as observation and classroom discussions alongside analysis of tests and homework to provide feedback on pupils' learning and to improve their classroom instruction.

2.4.3 Science teachers practice of summative assessment

Summative assessment is commonly referred to as assessment of learning, in which the focus is on determining what student has learnt at the end of a course (Harlen, 2013). In other words, summative assessment refers to assessment carried out for the purpose of reporting achievement at a particular time. It helps to determine to what extent the instructional and learning goals and objectives have been met. While summative assessment is not intended to have direct impact on learning as it takes place, it nevertheless can be used to help learning in a less direct but necessary way because it provides a summary of students' learning to inform the next teacher when students move from one class to the next or from one school to another. It also enables teachers, parents and the school to keep record of students' learning, both as individuals and as members of a group or class (Harlen, 2013). Summative assessment employs a variety of tools and methods for obtaining information about what has been learned. In this way, summative assessment provides information at the student, classroom, and school level. Summative assessment informs instructional practice in several ways. It serves both as a guide to teaching methods and improving curriculum to better match the interests and needs of students. Harlen (2013) identifies six key components of summative assessment. These key components help to define the practices of summative assessment in the natural science classroom.

Defining characteristics of effective summative assessment include clear alignment between assessment, curriculum, and instruction, as well as the use of assessments that are both valid and reliable. The teacher involves students in special tasks or tests as part of, or in addition to, regular work. Thus, information from projects, tests, exercises, artefacts, student portfolio, class presentations as well as evidence about performance in relation to relevant understanding and competencies should form part of summative assessment. (Harlen, 2013). This is usually effective in 'internal' summative assessment. Thus, summative assessment is undertaken by the teacher, for example, mid-term or end of term examination.

Summative assessment takes place at certain times when achievement is to be reported. The teacher and the school undertake summative assessment of students at regular intervals such as at the end of a particular topic, course, term, year, etc. For instance, class tests are sometimes conducted at the end of a topic to ascertain students' performance. Mid-term assessment and end of terms examinations are useful forms of summative assessment as they are conducted at regular intervals to report on students' progress. External examination bodies also conduct end of course examination such as Basic Education Certificate Examination (BECE) and West African Senior Secondary School Certificate Examination (WASSCE).

Summative assessment relates to students' achievement of broad educational goals expressed in general terms rather than the goals of particular learning activities. Evidence is interpreted in relation to how students have performed in relation to broad goals and schemes. For instance in the Basic Education Certificate Examination (BECE), all students across Ghana are assessed with the same questions and marking schemes which cover the entire basic education course. The assessment covers a wide range of topics and competencies across the curriculum.

Summative assessment also involves the achievement of all students being judged against the same criteria or marking scheme. Assessment for summative purposes had to be reliable and therefore tests that can easily be controlled are normally presented to students in the same way and thus, give the same opportunities for all students to show what they can do. For instance, in the Basic Education Certificate Examination (BECE), all students across the country take the same test and perform the same tasks. The same marking scheme or rubric is used for all students no matter the district or region they come from. This uniform procedure allow for comparability between results of students who take the test at different places.

In summative assessment which is undertaken by national examination bodies, several information about students' achievement are not assessed. For example, students' ability to work with each other, follow rules to carry out investigations, ability to observe and make informed judgments. These reduce the reliability of the assessment results. However, to ensure reliability, examiners have introduced measures such as assessing certain skills demonstrated by students on the paper, introducing performance test (practical work), embedded test which are set in the context of regular work, multiple choice where alternative answers are provided, words as well as open-ended test items where students write answers in their own words. In classroom-based summative assessment such as end of term exams, a wide range of achievements can easily be assessed which increases reliability. For example, evidence on observation of students' involvement in scientific investigation, a portfolio of work collected over a period of time, student's notebook and individual or group presentation.

Finally, summative assessment provides limited opportunities for student self-assessment. In general, students do not have a role in summative assessment because the tests are given at the end of the course and students are expected to answer questions. To ensure students' involvement, assessment questions provide opportunity for students to produce a plan on paper for addressing a particular problem. Thus, tasks should involve students using their knowledge and not just recall. When objectives are clearly specified and connected to instruction, summative assessment provides informative about a student's achievement of specific learning objectives.

Harlen (2013) states that summative use of assessment can be grouped into 'internal' and 'external' to the school community. Internal uses include regular grading for record keeping, informing decisions, about courses to follow where there are options within the school, and reporting to parents and to students themselves. Teacher-made tests or examinations are commonly used in internal summative assessment.

External uses include certification by examination bodies such as WAEC, selection for employment or for further education, monitoring the schools' performance and school accountability. Natural science teachers have primary responsibility for designing and using formative and summative assessments to evaluate the impact of their own instruction and gauge the learning progress of their pupils. Teacher judgments of pupil achievement is central to classroom and school decisions including but not limited to instructional planning, screening, placement, referrals, and communication with parents (Moss, 2013). Appiah (2015)) found that JHS science teachers mostly used summative form of assessment in their instructions since they found it easier to implement.

According to Moss (2013), classroom assessment, embraces a broad spectrum of activities from constructing paper-pencil tests and performance measures, to grading, interpreting standardized test scores, communicating test results, and using assessment results in decision-making. Teachers are regarded as the foundation for bringing about positive change and preparing pupils for future endeavors. It is very essential therefore, to understand natural teachers' practices particularly how they assess and evaluate pupils' learning outcomes.

2.4.4 School Based Assessment (SBA)

School Based Assessment (SBA) was introduced into the school system in September 2008. SBA, which replaced the continuous assessment is a very effective system for teaching and learning if carried out properly. According to the CRDD (2007), the new SBA system is designed to provide schools with an internal assessment system that will help schools to achieve the following purposes:

- Standardize the practice of internal school-based assessment in all schools in the country
- Provide reduced assessment tasks for each of the primary school subjects
- Provide teachers with guidelines for constructing assessment items/questions and other assessment tasks
- Introduce standards of achievement in each subject and in each class of the school system
- Provide guidance in marking and grading of test items/questions and other assessment tasks
- Introduce a system of moderation that will ensure accuracy and reliability of teachers' marks
- Provide teachers with advice on how to conduct remedial instruction on difficult areas of the syllabus to improve pupil performance

The previous continuous assessment begun in 1987 as a method of evaluating the progress and achievement of students in educational institutions. Continuous assessment marks and external examination scores were used to determine the final grade of students at the end of their programmes (BECE, WASSCE). This mode of assessment was abandoned because as stated by the GES Assessment Services Unit (ASU, 2008), the work involved in computing CA marks appears cumbersome for teachers they experience difficulty in the large number of assessments pupils have to go through and the larger number of mark recordings they have to make. Also, it has limited number of projects works to make pupils apply their knowledge to produce something practical. The continuous assessment therefore was replaced due to cumbersome assessment tasks and lack of uniformity and accuracy of assessment tasks in schools across the country (CRDD, 2012).

Through the introduction of the SBA, "projects" has been made the central part of learning in Ghanaian basic schools because it is through school projects that students and pupils will have the opportunity to apply their learning in practical terms to develop new ideas, new processes and new products and thereby, acquire the critical thinking skills and habits that will help them in their future careers and in their personal lives (CRDD, 2012).

The new SBA consist of 12 assessments a year instead of the 33 assessments in the previous continuous assessment system. This means a reduction by 64% of the work load compared to the previous continuous assessment system. It has also been recommended that, a pupil selects one project topic for each term. Projects for the second term should be undertaken by teams of pupils as Group Projects to encourage pupils to apply knowledge and skills acquired in the term to write an analytic or investigative paper in Natural Science (CRDD, 2007; xiv).

The Ghana Education Service (2013) report that little attention has been given to the implementation of SBA in Ghanaian basic schools. Oduro (2015) found that primary school teachers were still using the old continuous assessment format instead of the SBA while some teachers were not aware of SBA and still practiced the old system of continuous assessment (CA). She revealed that basic school teachers had not been trained for the implementation of SBA. "Teachers' lack of engagement in new assessment practices and the lack of training could be linked to the disconnection between them and the ASU" (Oduro, 2015, p.149). Similarly, Appiah (2015) found that just a handful of science teachers assessed their pupil through project work and used the SBA to improve pupils' learning by encouraging them to produce essays, poems, and artistic work and other items of learning using appropriate process skills, analysing information and other forms of data accurately and make generalizations and conclusions. Such a situation has implications for decision makers such as the ASU and teachers who are tasked to conduct assessment using the SBA.

2.5 Summary

Teachers' sense of efficacy belief which is derived from Bandura's (1986) social cognitive theory is defined as the belief in one's capabilities to deal with different situations and perform specific tasks required to produce a given outcome (Bandura (1997). Personal efficacy belief is the judgement of one's belief in his/her capability and competency to succeed in a given task while outcome efficacy is an individual's judgement about a performance to be realized in a given task based on personal experiences. Teachers' efficacy beliefs are related to effectiveness, student motivation, adoption of curriculum innovations and child-centred instructional approaches (Ngman-Wara & Edem, 2016; Woolfolk &Hoy, 2000).

Shulman (1986) introduced the concept of Pedagogical Content Knowledge as an element of specific knowledge base for teaching. PCK involves the combination of content and appropriate pedagogy to understand how topics and issues are organized, represented and adapted to the diverse interests and abilities of learners for effective instruction (Shulman, 1987). Shulman proposed seven categories knowledge: a. content knowledge, b. general pedagogical knowledge, c. curriculum knowledge, d. pedagogical content knowledge, e. knowledge of learners and their characteristics, f.

knowledge of educational contexts, g. knowledge of educational ends, purposes, and values, and their philosophical and historical grounds.

Natural science teachers need to understand what pupils know or do not know and therefore need to assess their pupils. Recommended assessment approaches in the natural science curriculum includes formative assessment, summative assessment and School Based Assessment. The SBA included school projects that is intended to give pupils the opportunity to apply their learning in practical terms to develop new ideas, new processes and new products and thereby, acquire the critical thinking skills and habits that will help them in their future careers and in their personal lives. Researchers proposed that assessment should form integral part of instruction.

Natural science teachers must select instructional practices in the classroom that promote inquiry-based instruction and critical thinking. The natural science curriculum emphasized child-centred instructional approaches to science teaching to promote active learning of pupils. Researchers suggest that self-efficacy beliefs play a role in determining how teacher teachers approach their teaching while curriculum knowledge also determines teacher’s instructional and assessment practices. Natural science teachers’ sense of efficacy belief and curriculum knowledge plays is likely to influence the type of instructional approach they will adopt in their teaching. It therefore plays a critical role in their ability to successfully implement the 2007 natural science curriculum.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter provides detail description of the methodology employed to collect data for the study. It includes the research design, population and setting of the study, sample and sampling procedures, research instrument and data collection procedures. It ends with data analysis.

3.1 Research Design

According to Amin (2005), research design is a master plan specifying the research methods and procedures. It is a detailed plan, which researchers use to guide and focus the research. Creswell (2012) also refers to research design as a detailed plan on how a research study is to be conducted, operationalizing variables so that they can be measured, selecting a sample of interest to study, collecting data to be used as a basis for testing hypothesis, and analyzing results.

In this study, sequential explanatory mixed method research design was used for data collection and analysis. Through sequential explanatory mixed method design, quantitative data were collected and analysed followed by qualitative data. The qualitative data was used to explain and interpret the findings from the quantitative data (Creswell, 2012). According to Creswell, Plano, Hanson and Clark (2003), a mixed method design involves the collection or analysis of both quantitative and qualitative data in a single study in which the data are collected concurrently or sequentially, are given a priority, and involve the integration of the data at one or more stages in the process of research.

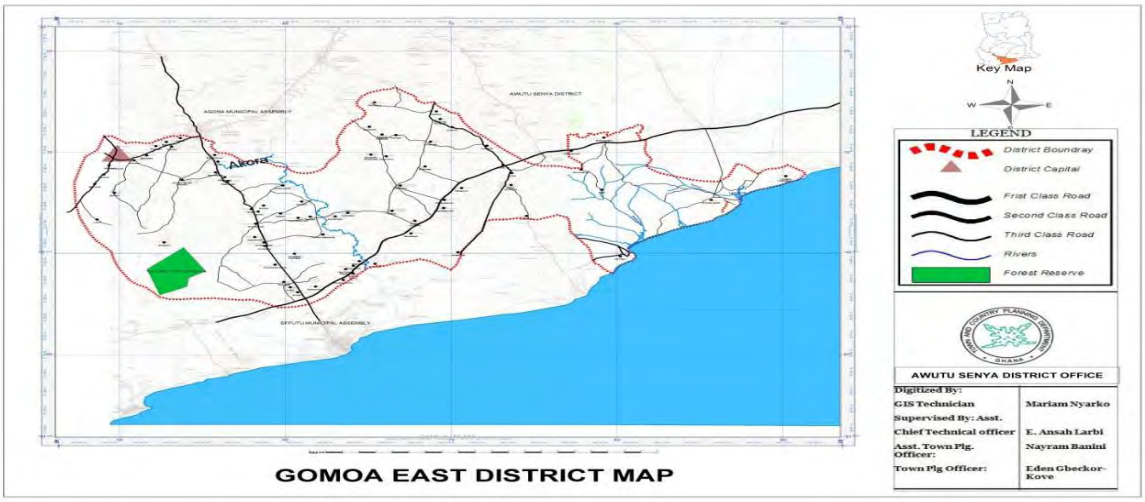
This study adopted the mixed method because the researcher used questionnaire to collect quantitative data on natural science teachers' curriculum knowledge and self-efficacy beliefs in the Gomoa East District of the Central Region which was followed by observations to determine the teachers' classroom instructional and assessment practices. Interview was used to explore the issues of natural science teachers' curriculum knowledge, self-efficacy and classroom practices in-depth. The qualitative data (classroom observation and interview) therefore strengthened the quantitative data obtained from the questionnaires.

Mixed method has the advantage to reduce some of the problems associated with singular methods. In justifying the case for the use of the mixed approach, Babbie and Mouton (2004) state that using different sources and methods in the research process, the researcher can build on the strengths of each type of data collection and minimize the weaknesses of any single approach and therefore maximize the strength of the qualitative and the quantitative methods used together.

3.2 Setting

The study was carried out in the Gomoa East District of the Central Region of Ghana.The District is one of the 17 Districts in the Central Region of Ghana. Its administrative capital is Afransi. The district was carved out of the then Gomoa District in 2008 by the Legislative Instrument 1883 and became operational on 29th February, 2008. It occupies an area of 539.69 square kilometres with a total population of 207,071, comprising 47.5 percent males and 52.7 percent females (Ghana Statistical Service, 2010). It is located in the south-eastern part of the Central Region and it is uniquely situated among other districts, bordered on the North by the Agona West Municipal, North East by Agona East district, on the South-West by Gomoa West, on the East by Awutu-Senya District and Ga South in the Greater Accra Region and to the South by Effutu. The District is boarded at its south-eastern side by the Atlantic Ocean.

Figure 3.1 Map of Research Area (Gomoa East District)



Source: Ghana Statistical Service (2015)

The district exhibits characteristics of both urban and rural settlements. However, there are more rural communities than urban communities in the district but majority of the population reside in its few urban areas. For instance, the average household per house for the district according to the 2010 census is 1.4 with the rural areas recording a greater number than the urban areas implying that there are more persons in a house in those settings than in the urban areas. Budumburam which is the largest refugee camp in the country is located in the district. A total of 78,059 children aged 3 years and older in the Gomoa East District are currently attending school. Out of that total population, 36, 533 representing 46.8% are in primary school comprising 51.3% males and 48.7% females. There are 77 Primary schools in the district as at January, 2017. These schools are categorized into 10 circuits with each circuit having an average of seven schools.

3.4 Population

Population refers to the complete set of individuals that have common observable characteristics in which the researcher is interested in studying (Agyedu, Donkor & Obeng, 2013). Castillo (2009) also defines a research population as a large well-defined collection of individuals having similar features.

The target population for the study comprised all Primary School teachers' in the Gomoa East District. There are 77 public primary schools in the District with 474 teachers. Table 3.1 gives the breakdown of the district into educational circuits and the number of schools and lower primary teachers in each circuit. Out of this number, a total of 237 taught at the lower primary level (class 1 -3). This constituted the accessible population.

Table 3.1: Primary Schools in Gomoa East District

Name of Circuit	**Primary schools**	
	Number of primary schools	**Number of Lower primary teachers**
Obuasi	6	21
Afransi	10	30
Aboso-Benso	6	18
Ekwamkrom	8	24
Pomadze	9	27
Potsin	7	21
Buduatta	7	21
Ojobi	8	24
Buduburam	9	27
Nyanyano	7	24
Total	**77**	**237**

Source: *Gomoa East Educational Directorate (March, 2017*

3.5 Sampling Technique

According to Fraenkel and Wallen (2006), there are several sampling methods that can be used to draw a representative sample from accessible population. Purposive sampling technique was used to select all lower primary teachers in the district. Purposive sampling starts with a purpose in mind and the sample is thus selected to include people of interest and to exclude those who do not suite that purpose (Fraenkel & Wallen, 2006).Since the study sought to explore teachers' curriculum knowledge, self-efficacy belief towards natural science teaching and their classroom practices, the lower primary school teachers were sampled for the study. Natural science is taught only in the lower primary, that is, primary one to three and lower primary teachers are classroom teachers and by extension, they teach natural science. So the teachers would be able to provide the information needed to achieve the objectives of the study. The sample was representative of natural science teachers in the Central Region since the teachers had similar professional training with other teachers in the region from the initial colleges of education and also used similar prescribed natural science curriculum materials provided by the Ghana Education Service. The sample consisted of all the 237 natural science teachers in the Gomoa East District of the Central Region of Ghana.

Stratified random sampling technique was used to select a sub-sample of 10 teachers for the qualitative phase of the study which involved classroom observation and interviews. The sample was put into two strata made up of 20 teachers each. One stratum was made up of teachers with high curriculum knowledge and the other made up of teachers with low curriculum knowledge. Each stratum was further stratified into male and female respondents and proportionate sampling was used to obtain three males and seven females.

3.6 Research Instruments

The data collection instruments were questionnaires, interviews, and an observation guide.

3.6.1 Questionnaires

A questionnaire, Natural Science Teachers Curriculum Knowledge Questionnaire was used to collect data on natural science teachers' curriculum knowledge (Appendix A) while the Science Teaching Efficacy Beliefs Instrument (STEBI-A) for in-service teachers was adapted and used to collect data on the teachers' self-efficacy beliefs (Appendix B).

According to the Merriam Webster Collegiate Dictionary (2016), a questionnaire is a set of printed questions for obtaining statistically useful personal information from individuals. Questionnaires are popularly used in quantitative research to collect data. They can be filled away from the researcher in the form of a self-administered, group administered or postal administered questionnaire. Questionnaires ensure the confidentiality of responses and saves time. In addition, they are widely used in social science research and education. Patton (2002) emphasizes that about 90% of the research in the social sciences is conducted using questionnaires.

3.6.2 Natural Science Teachers' Curriculum Knowledge Questionnaire (NSTCKQ)

The questionnaire consisted of 38 items which were distributed among three sections. The NSTCK was adapted from Appiah (2015). The original questionnaire developed by Appiah was Junior High School Teachers' Curriculum Knowledge (STCK) and Assessment Practices. It consisted of 59 items which were grouped under three sections. The first section was made up of 6 items, section two was made up of

30 items while section three was made up of 23 items. The items consisted of both open-ended and multiple choice. The questionnaire was adapted to suite the natural science curriculum and the number of items reduced to 35 to reflect the purpose of the study.

The adapted instrument consisted of three parts. Part one was made of six items and used to collect data on the teachers' background including academic qualification, professional qualification and number of years of teaching experiences as well as classes taught. Part two which was made up of sixteen items sought to elicit information on the participants' knowledge on the natural science curriculum, including the rationale for teaching natural science, themes and topics outlined in the curriculum, suggested teaching strategies as well as other curriculum materials. Part three consisted of thirteen items which sought information on the participants' classroom assessment practices. The NSTCK questionnaire contained both closed ended and open-ended items. The latter allowed the participants to give reasons for some of their responses where necessary. The Cronbach alpha value of the NSTCK questionnaire was 0.72 which indicated a high reliability and therefore suitable for the study. This Cronbach alpha value was close to the one obtained by Appiah (2015) which was 0.77.

3.6.3 Science Teachers' Self-Efficacy Beliefs Instruments (STEBI-A)

The science teachers' self-efficacy beliefs instrument (STEBI) is an instrument based on Bandura's definition of self-efficacy as a situation-specific construct. The instrument was developed by Enoch and Riggs (1990) and it is widely used to measure pre-service and in-service teachers' self-efficacy beliefs regarding science teaching.

The STEBI consists of 23 items on a five-point Likert type scale. Each item consisted of a statement followed by five responses/options with numerical weightings: Strongly Agree = 5, Agree = 4, Uncertain = 3, Disagree = 2, Strongly Disagree = 1. A respondent is expected to select the option that best represents his/her opinion on the item. The instrument has two subscales: personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE). The PSTE has 13 items (2, 3, 5, 6, 8, 12, 17, 18, 19, 20, 21, 22, 23) while the STOE has 10 items (1, 4, 7, 9, 10, 11, 13, 14, 15, 16).The Personal science teaching efficacy beliefs refer to the extent that teachers believe that they have the capacity to positively affect students' achievement. The science teaching outcome expectancy reflects science teacher's beliefs that student learning can be influenced by effective teaching. The Cronbach alpha of the STEBI instrument was 0.75 which indicated a high reliability and therefore suitable for the study.

The STEBI was adapted for this study since it sought to determine the self-efficacy beliefs of in-service natural science teachers (Appendix B). The statements in the questionnaire were worded to suite the present study. For example, words such as natural science was used in place of science since the questionnaire is used to determine natural science teachers' self-efficacy beliefs regarding natural science teaching.

3.6.4 Observation

Mitchell and Jolley (2010) defined observation as the process of watching a behaviour. Observation can be used to collect exploratory data on what is happening on a situation or to put into the data obtained by questionnaire or interviews in perspective (Robson, 1995). Creswell (2012) recommends the use of observational protocol as a method for recording notes. This is to enable the researcher to know exactly what goes on in the classrooms. The observation provides the researcher the opportunity to follow up on the results emanating from the questionnaires and the interviews.

A non-participant observation schedule was used to collect data on natural science teachers' classroom practices (Appendix C). The observation schedule was an inquiry based observational schedule which was developed by Bybee (1997) and adapted for this study. The adaptation of the observation schedule was guided by the stages of lesson delivery outlined in the curriculum. The stages are introduction, presentation and evaluation. The introduction stage was made up 5 indicators which sought to find out how teachers stated the purpose of the lesson, create curiosity, elicit responses to unearth prior knowledge and link prior knowledge to the topic. The presentation stage was made up of 22 indicators which sought to determine how natural science teachers practiced inquiry-based instruction while the evaluation stage was made up of 7 indicators which sought to find out how teachers evaluated their lessons and guided pupils to apply concepts.

3.6.5 Semi-Structured Interview Guide

Semi-structured Interview guide was used to collect qualitative data to validate the information provided on the questionnaire (Appendix D). An interview is a survey in which the researcher orally asks participants questions (Mitchell, & Jolley, 2010) and interview guides are data collection instruments used through direct and verbal interaction between respondents and the researcher. Fraenkel and Wallen (2009) argue that interview guides are important in sourcing for volumes of qualitative data.

The interview guide was made up of 16 items which sought further clarification on the information provided on the questionnaires. The open-ended items allowed for further probing based on the responses given by the participants.

3.7 Validity

Validity of a research instrument is determined by how well it measures the concept(s) it is intended to measure (Awanta & Asiedu-Addo, 2008; Ruland, Bakken & Roislien, 2007). It indicates the degree to which an instrument measures the construct under investigation. Face, Content and Construct validity of the instruments were established.

3.7.1 Face Validity

The researcher gave the instruments to colleagues and other graduate students of the University of Education, Winneba and the supervisor to establish the face validity of the instruments. They were requested to carefully and systematically scrutinize and assess the instruments for its relevance and face validity. Issues such as length of questions, framing of questions, and ambiguity were considered. The feedback from the graduate students and the supervisor were factored into the final preparation of the instruments.

3.7.2 Content Validity

Content validity is a measure that gauges whether there is adequate coverage of all the research questions (Cooper & Schindler, 2008). It indicates whether the technique assesses or measures what it is supposed to measure (Ruland, Bakken & Roislien, 2007). In other words, it is a judgmental assessment on how the content of a scale represents the measures.

According to Cooper and Schindler (2008), there are two ways of determining content validity. Firstly, the designer may determine it through a careful definition of the topic of concern, the items to be scaled, and the scale to be used. Secondly, the researcher supervisor who is an expert may judge how well the instrument meets the standard. Based on this knowledge, suggestions of my supervisor and other lecturers who are experts in curriculum studies were sought to content validate the instruments.

3.7.3 Construct Validity

Construct validity refers to the extent to which measures conform to expectation formed from theory for hypothesized construct (a variable which is not directly observable but is inferred from other variables). Factor analysis was conducted to establish construct validity (Mitchell & Jolley, 2010). The researcher conducted exploratory factor analysis (EFA) to ensure that the science teachers' self-efficacy belief instrument was (STEBI –A) was construct valid.

3.8 Reliability

According to Cooper and Schindler (2008), reliability refers to the consistency of a measure. A test is reliable if we get the similar result repeatedly, that is, the extent to which results are consistent over time and if the results of a study can be reproduced under a similar methodology (Joppe, 2000). The data from the pilot test was used to determine the Cronbach alpha reliability coefficient of STEBI-A.

The Cronbach alpha value for STEBI- A was 0.75 and the Cronbach alpha value for Natural Science Teacher' Curriculum Knowledge (NSTCK) questionnaire was 0.72. Experts argue that Cronbach alpha coefficient should be at least 0.70 to be indicative of high reliability (McMillan & Schumacher, 2010). Similarly, Patton (2002) argues that an item with reliability coefficient of between 0.7 and 0.9 has excellent internal consistency and measures what it purports to measure. Based on these assertions, the instruments are judged to be of high reliability and therefore suitable for data collection for this study.

The researcher sough expert advice for determining the reliability of the observational guide and the semi-structured interview guide. The criteria used were; credibility, transferability, thus, it should be usable in other places, dependability, thus their consistency over time and conformability, thus, how well suited they are with the objectives of the study. To achieve credibility, the researcher used observational guide and semi-structured interview guide to collect qualitative data for the study.

3.9 Pilot Testing of Instruments

A pilot test was carried out on the instruments to further analyse the content validity and determine the construct validity as well as the reliability where applicable.

To determine the strength and weaknesses of the Natural Science Teachers Curriculum Knowledge (NSTCK) Instrument and Natural Science Teachers' Self-Efficacy Belief Instrument (STEBI) questionnaires were pilot tested in the Effutu Municipality of the Central Region. A total sample of fifty (n = 50) natural science teachers were conveniently sampled for the pilot-test. The researcher used this sampling technique after taking into consideration time and other resources at his disposal. The researcher chose the municipality because it was deemed to have exhibited similar characteristics as the Gomoa East district where the study was conducted. The observational guide was also pilot-tested. Pilot-testing the instruments enabled the researcher to modify items that were difficult to understand, reduce ambiguities and incorporate new categories of responses that were identified as relevant to the study (Awanta & Asiedu-Addo, 2008).

3.10 Factor Analysis

According to Yong and Pearce (2013), factor analysis is a multivariate for simplifying interrelated measures so as to discover patterns in the variables to establish underlying dimensions between the variables and constructs. Exploratory factor analysis was conducted on the data collected with the STEBI-A following the procedure adopted by Enochs and Riggs (1990) since it was adapted for this study, it was imperative to determine its construct validity.

The data was analysed using principal component analysis (PCA) model of Statistical Package for Service Solution (SPSS) version 20. Before performing the PCA, suitability of data for factor analysis was assessed. The inspection of correlation matrix revealed the presence of many coefficients of 0.3 and above except those of items 7 and 13 which were - 0.14 and 0.22 respectively. Kaiser-Meyer-Oklin (KMO) coefficient was found to be.732 which exceeded the recommended minimum value of 0.6. This indicated that the data was adequate enough for factor analysis. Also, the Barlett's Test of Sphericity revealed a significant chi-square value of$x^2(253) = 917.413, p < 0.000$, supporting the factorability of the correlation matrix. An inspection of the screen plot revealed a clear break after the second component (Fig. 2). Using Catell's (1966) scree test, it was decided to retain two components for further investigation. To aid in the interpretation of these two components, varimax rotation was performed. The two factors accounted for 26.79% of the total variance.

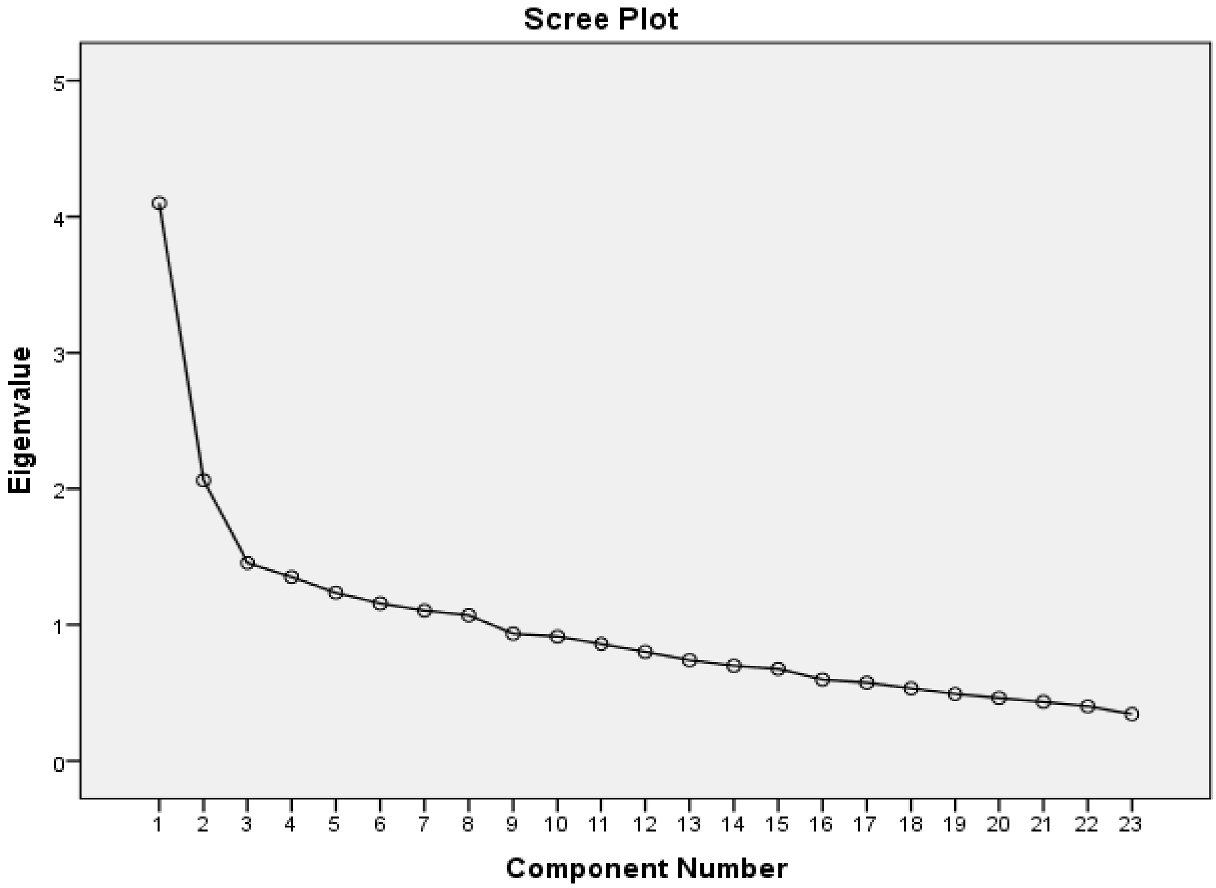


Fig. 2: Scree plot of factor analysis of STEBI-A

Table 3.2 presents the results of the factor analysis. Items 2, 12, 22, 18 and 5 cross loaded unto either factor but did not contribute to that factor and were therefore deleted. Also, items 7 and 13 did not load at all and they were therefore deleted (Appendix E)

Table 3.2: Rotated Component Matrix with Kaiser Normalization

Factors	**1**	**2**
Factor 1: STOE		
Q 16	.691	
Q 11	.587	
Q 14	.573	
Q 15	.556	
Q 4	.477	
Q 9	.468	
Q 1	.466	
Q 10	-.431	
Factor 2: PSTE		
Q 6		.625
Q 21		.589
Q 3		.563
Q 19		.561
Q 17		.526
Q 23		.480
Q 8		.475
Q 20		-.376

Factor 1 represents natural science teachers' outcome expectancy (STOE). The items that cluster on factor 1, science teachers' outcome efficacy belief regarding natural science teaching (STOE) were (Item 16, 11, 14, 15, 4, 9,1 and10) with an eigenvalue of 4.10 explained a total variance of 17.82% while factor 2 represents natural science teachers' personal science teaching efficacy (PSTE) (item 6, 21, 3, 19, 17, 23, 8, and 20) with an eigenvalue of 2.06 explained total variance of 8.96%.

3.11 Data Collection Procedure

The researcher administered the questionnaire with the help of circuit supervisors but personally administered the interview and also conducted the classroom observation. However, the services of the circuit supervisors were sought to administer the questionnaires to the teachers in the various circuits. The researcher obtained letter of introduction from the Department of Basic Education of the University of Education, Winneba, which was used to obtain permission from the District and heads of Primary Schools to carry out the study. The letter was sent to the Gomoa East Education Directorate in order to gain access to the schools, participants, and other document that would facilitate the study. The Educational Director subsequently granted permission to the researcher in order to have access to the participants.

The researcher personally met with the teachers of the various schools to familiarize himself with them and also to give them two weeks notification about the study and the interviews. The researcher informed the teachers about the purpose of the study and they were assured of the confidentiality and the fact that their anonymity would be protected. Data was collected in three phases. The first phase involved the administration of the questionnaires. The second phase involved observations while the third phase involved interviews. The arrangement in Table 3.3 guided the data collection phase of the study.

Table 3.3: Schedule of data collection

Visit	Purpose
First visit	Distribution of letters and getting acquainted with teachers
Second visit	Administration of questionnaires
Third visit	Classroom observation and interview of selected teachers

The researcher undertook a familiarization visit to schools in the District to distribute letters and also explain the purpose and benefit of the study to the teachers. Two weeks later, the researcher met with the circuit supervisors and gave them the questionnaires to distribute to the teachers in their circuits. Since the questionnaires sought to measure teachers' knowledge and self-efficacy beliefs, the circuit supervisors ensured that teachers completed the questionnaires and returned them on the same day. This was to ensure that teachers did not get the opportunity to communicate among themselves or refer to other materials for information. It took five days for the circuit supervisors to administer the questionnaires to all teachers in their circuits.

Two weeks after the collection of the questionnaire, the researcher visited the selected schools to observe the lesson of the 10 teachers sampled for the qualitative phase of the study. Two teachers were observed each day. The observation lasted for five days. The researcher observed and ticked any inquiry-based instructional practices by the teacher in the process of lesson delivery. The following keys were used to score participant's performance on the observation schedule: No Evidence = 0; Minimum Evidence = 1; Some Evidence = 2; Clear Evidence = 3; Clearer Evidence

= 4 or more ticks. In order to maintain confidentiality in this study, the researcher used symbols, T1, T2, T3, etc, to represent each of the participants. The participants were allowed to select a topic and design their own lesson. Each participant's lesson was observed once and each observation lasted for about 60 minutes. Notes were taken on issues observed but which were part of the observation schedule. Some of the issues were number of pupils in the classroom, the topic for the lesson, teaching and learning materials used in the lesson and physical arrangement of the classroom. The observation process was completed in five days. Each participant was interviewed immediately after the observation. The researcher further probed the participants for more information. Each interview lasted for about 45 minutes.It was one-on-one interview. The interviews, with the permission of the interviewers were tape recorded and later transcribed by the researcher. The whole data collection process was undertaken in the second term of 2016/2017 academic year, specifically, February to April, 2017.

3.12 Data Analysis

According to Berg (2001), data analysis involves the breaking up of data into manageable themes, patterns, trends and relationships. The data collected for the study were analysed separately as quantitative and qualitative data.

3.12.1 Quantitative data

The quantitative data was collected through the NSTCK and the STEBI. Descriptive statistics in the form of simple percentages, frequency, mean and standard deviation and inferential statistics (Pearson Product Moment Correlation) were used to analyze the quantitative data. Statistical Product for Service Solution (SPSS) software version 20 was used to analyse the quantitative data. Frequency and percentages counts were used to describe natural science teachers' level of curriculum knowledge and classroom instructional and assessment practices. Data obtained from part I of the NSTCK instrument were organized into frequency counts and percentages and used to understand the background information of the participants. That of part II was also organized into frequencies and converted into percentages and used to describe teachers' knowledge about the natural science curriculum. This was used to answer research question one.

Pearson Product-Moment correlation was used to assess the strength and nature of relationship between natural science teachers' background factors and content knowledge of the natural science curriculum. This was used to answer research question two.

Descriptive statistics were used to organize the in-service natural science teachers' scores on the STEBI-A into mean scores and standard deviations. This was used to answer research question three. The means and standard deviations were used to understand the data. Mean ratings of 1.0 to 1.75 represents low efficacy, 1.76 to 2.25 represents moderate efficacy, 2.26 to 3.25 represents high efficacy and 3.26 to 4.0 represents very high efficacy. This criteria was used by Shamsid-Deen and Smith (2006) and Ngman-Wara (2012) in similar studies involving pre-service science teachers.

Data from part III of the NSTCK questionnaire was also organized into frequency counts and percentages and used to describe teachers' classroom assessment practices. The data collected through the observational schedule was used to validate the teachers' responses on the questionnaire and also to determine whether the instructional approaches of natural science teachers were inquiry-based.

The data was analysed using frequency and percentages for easy discussion. The keys used for each activity were based on the total number of ticks on each indicator. Total frequency and percentage for each indicator as well as total frequency and percentage for each teacher was determined and categorized as follows and used to describe the level of evidence of the teacher's use of child-centred or teacher-centred instructional strategies.

Table: 3.4: Percentage range used to categorize teachers

Evidence	Percentage range%	Level of instructional approach
No Evidence	0	Teacher-centred instructional approach
Minimum Evidence	1 – 25	
Some Evidence	26 – 50	
Clear Evidence	51 – 75	Child-centred instructional approach
Greater Evidence	76 – 100	

Teachers who scored more than 50% on the schedule were categorized as advocates of leaner-centered instruction while those who scored less than 50% were categorized as advocates of teacher-centered instruction. The analysis of data from the observation was used to answer research question four.

3.12.2 Qualitative data

The qualitative data were obtained from the open-ended items on the NSTCK questionnaire, interviews and lessons observed were analysed thematically in order to answer the research questions. Based on the responses to the questionnaire items, codes were assigned to each item, and themes were identified in the process. The responses were then organized into the themes and analysed.

Interview data collected from teachers were used to validate the responses obtained from the questionnaires. The interview guide focused on teachers' knowledge of the natural science curriculum, self-efficacy beliefs and classroom instructional and assessment practices. All interviews were audio-taped after the researcher sought permission from the participants and later transcribed by listening to the tapes severally. The researcher then transcribed the recording word-for-word. The researcher later read through the texts to identify emerging themes. The themes results were then analysed using emerging themes to support the finding from the questionnaires. Verbatim quotations were used to support the discussions.

3.13 Ethical Consideration

Ethical issues that were considered in this study were the permission to collect data, confidentiality, anonymity and the protection of participants (Berg, 2001; Patton, 2002).

3.14 Confidentiality

The participants were assured that all the information obtained would be treated as confidential. That is, data was only used for stated purposes and no other person had access to interview data.

The names of teachers and schools were coded and not released in the research. Also, the names of teachers were not needed on the questionnaire and respondents were informed before they filled the questionnaire (Berg, 2001; Cooper & Schindler, 2008; Patton, 2002). This was done in order to avoid biased responses from participants. The learning atmosphere in the schools were also not disturbed during the data collection process and the data collected through questionnaires, interviews and observations were kept confidential and made available only to persons who had direct interest in this study. Computer data was protected by a password. At the end of the process, all documents would be shredded and tapes would be deleted (Walliman, 2006).

3.15 Anonymity

The researcher ensured that no one could identify the participants from the information provided. This was done by not indicating names, addresses and particular names of individual schools of participants. All these were not indicated on the formal report presented.

CHAPTER FOUR

RESULTS

4.0 Overview

This chapter presents the findings on Natural Science Teachers' Curriculum Knowledge, Self-Efficacy Beliefs, and Classroom Practices. The quantitative data was used to answer research questions 1, 2 and 3. While the qualitative data from classroom observation and interview was used to answer research question 4. The findings were presented in eight sections:

a. Characteristics of the study sample;
b. Teachers' knowledge of the natural science curriculum materials;
c. Natural science teachers' knowledge about the basic science curriculum;
d. Science teachers content knowledge of the natural science curriculum;
e. Natural science teachers' knowledge of the guidelines for assessment and scoring of SBA;
f. Relationship between natural science teachers' background factors and their content knowledge of the natural science curriculum;
g. Natural science teachers' self-efficacy beliefs regarding natural science teaching; and
h. Natural science teachers' classroom instructional and assessment practices.

4.1 Demographic information on the characteristics of the study sample

Demographic information of each participant was collected. The results of the analysis are shown in Table 4.1

Table 4.1: Summary of Demographic Characteristics of Natural Science Teachers in Gomoa East District ($n = 232$)

Demographic factors	Category	Frequency	Percentage (%)
Sex	Male	67	28.9
	Female	165	71.1
	Total	**232**	**100.0**
Academic qualification	SSSCE/WASSCE	81	34.9
	G.C.E. Ordinary level	15	6.5
	G.C.E. Advanced level	5	2.2
	Diploma in Basic Education	93	40.1
	B. Ed Science	18	7.8
	HND	5	2.2
	Agricultural Science	3	1.3
	Others	12	5.2
	Total	**232**	**100.0**
Professional qualification	Cert 'A' 4 year	16	6.9
	Cert 'A' Post Sec	15	6.5
	Diploma in Basic Education	128	55.2
	B. Ed (Basic Education)	73	31.5
	Total	**232**	**100.0**
Number of years of teaching	0 - 3 years	40	17.2
	4 - 6 years	57	24.6
	7 - 10 years	41	17.7
	More than 10 years	94	40.5
	Total	**232**	**100.0**
Classes taught	Class 1	66	28.4
	Class 2	68	29.3
	Class 3	70	30.2
	Class 1 and 2	3	1.3
	Class 1 and 3	9	3.9
	Class 2 and 3	6	2.6
	Class 1, 2 and 3	10	4.3
	Total	**232**	**100.0**
INSET	Yes	90	38.8
	No	142	61.2
	Total	**232**	**100.0**

The questionnaire was administered to 237 natural science teachers in the Gomoa East District in the central region of Ghana. Out of this number, 232 participants completed and submitted their questionnaire making a return rate of

97.9%. Out of the 232 natural science teachers, 28.9% (67) were males and71.1% (165) were females. This shows that, majority of natural science teachers in the District at the time of this study were females. More female teachers are usually posted to the lower primary level and therefore women represent a significant majority of the teaching work force at the lower primary school level in the Gomoa East District.

Also, majority of teachers (40.1%, 93) in the district had Diploma as their highest academic qualification. This is followed by those with SSSCE/WASSCE which is made up of 34.5% (81) teachers, then B.Ed Science degree 7.8% (18) teachers and G.C.E Ordinary level 6.5% (15). G.C.E Advanced level and HND had the same number of teachers 2.2% (5) while Agricultural science had the least number of teachers (1.3%, 3). Participants who fell within other academic qualifications were 12 (5.5%). Only about 8% of teacher had specialized training in science.

The highest number of professionally trained teachers were those with diploma in basic education (55.2%, 128). This was followed by B.Ed degree in basic education (31.5%, 73) whiles the least number of professionally trained teachers had Cert 'A' Post Sec (16%, 15). This shows that all natural science teachers who participated in the study had some level of professional training as teachers.

The results showed that natural science teachers had varied years of teaching experience. The teachers' years of teaching ranged from zero to above ten years. The respondents who had taught for 6 years or below were 97(41.8%). Also those who taught between 7 to 10 years were 41 (17.7%) while those who taught for more than 10 years were 94 (40.5%). This indicates that majority of the teachers had taught for more than ten years. Since the natural science curriculum was introduced in the year 2007, it means a good number (40.5%) of teachers in the Gomoa East district were teaching at the time the curriculum was introduced.

The results further indicates that 87.9% (204) teachers taught only primary 1, 2 or 3.

Also, 7.8% (18) of the teachers taught two classes while 4.3% (10) teachers taught all three classes. This shows that majority of teachers taught one class while few of them taught two or three classes.

Also, the results show that about 39% (90) teachers had an In-service Education and Training (INSET) on natural science curriculum while 61.2% (142) did not have any form of In-service training on natural science curriculum. This means that majority of the teachers have no training on natural science curriculum and its implementation. This implies that majority of teachers will have challenges in implementing the natural science curriculum. Also, there is likely to be a gap between the intended curriculum and the enacted curriculum when teachers are not adequately trained to effectively implement the curriculum.

4.2 Research question1: What is natural science teachers' content knowledge of the natural science curriculum?

The research question sought to find out the level of natural science teachers' knowledge of the natural science curriculum. Results from Part II sections A, B and C of the Natural Science Teachers Curriculum Knowledge (NSTCK) questionnaire were used to answer the research question. Section A of the questionnaire sought to find out natural science teachers knowledge of the natural science curriculum materials, section B focused on natural science teachers' knowledge about the organization of the syllabus while section C sought to find out natural science teachers' content knowledge of the natural science curriculum. The responses of teachers were organized into frequency counts and percentages.

Section A: Teachers' knowledge of the natural science curriculum materials

The analysis of the results of participant's responses to items of section A of the questionnaire are presented in Table 4.2

Table 4.2: Natural science teachers' knowledge of the natural science curriculum materials

Curriculum materials	Responses	Frequency	Percentage (%)
Type of curriculum materials in schoc			
Presence of syllabus	Yes	176	75.9
	No	56	24.1
Presence of Teachers' Guide	Yes	132	56.9
	No	100	43.1
Presence of Pupils' textbook	Yes	202	87.1
	No	30	12.1
Presence of Charts/Picture	Yes	63	27.2
	No	169	72.8
Presence of Other materials	Yes	17	7.3
	No	215	92.7
No teaching –learning materials	Yes	4	1.7
	No	228	98.3
Topics in teachers' guide and textbook correspond to those in syllabus	Yes	171	73.7
	No	20	8.6
	Not sure	41	17.7
Teaching and learning activities in teachers' guide and textbooks correspond to that of syllabus	Yes	163	70.3
	No	22	9.5
	Not sure	47	20.3
Use of curriculum materials in lesson preparation and delivery	Yes	212	91.4
	No	20	8.6
How often materials are used for lesson preparation and presentation	Sometimes	44	19.0
	Often	33	14.2
	More often	25	10.8
	Always	119	51.3
	No response	11	4.7

The data presented in Table 4.2 indicates that 75.9% (176) of the teachers had the syllabus in their schools while 56.9% (132) teachers had the teachers' guide in their schools. In addition, 87.1% (202) teachers indicated that there were pupils' textbooks in their schools. Also, 72.8% (169) teachers said they did not have charts and pictures in their schools for teaching natural science. Furthermore, as many as 92.7% (215) of the teachers said they did not have other supplementary materials for teaching natural science. This means that majority of teachers had the main curriculum materials such as syllabus, textbooks and teachers' guide in their schools. However, greater number of them did not have other supplementary teaching and learning materials.

Even though majority (91.4%) of the respondents indicated that they used curriculum materials in their lesson preparation and delivery, only about half of them (51.3%, 119) always used curriculum materials in their lesson preparation and presentation. This means that some of the teachers teach without the use of curriculum materials such as syllabus, teachers' guide and textbooks.

Interview was used to probe further how the presence or absence of curriculum materials influence their lesson preparation and presentation. The responses indicates that all the teachers lacked at least one curriculum material in their schools which adversely affected their lesson preparation and lesson delivery

The following excerpts are some of the responses of the interviewees:

> *We have some materials but they are not sufficient. The whole upper primary had only one syllabus for science. We don't have a syllabus for lower primary. I also don't have teachers' guide. I don't also have charts. It involves money and if I want then I have to use my own money. I only have one textbook and the children don't have textbooks*
>
> *I sometimes go to the teacher in the next school to take her syllabus and use. And this is very difficult. The government should supply syllabus to us* (T1, Interview)

One other interviewee asserted that:

I don't have syllabus in the school. My son downloaded it from the net and it is on the computer so that is what I use. I know the class three teacher has but she always uses it so I can't go for it. Because I don't have a syllabus, it makes teaching difficult. Even the syllabus alone doesn't give you much details about the topic.

The syllabus gives you about two lines so if you don't make your own research, it will be difficult for you to teach effectively. I was having teachers' guide previously when I came but now I can't find it. I don't know whether the class teacher who was here had taken it. All the textbooks we have for children are torn. I think this is the best that we have so I am using it (Referring to an old natural science textbook*).* (T2)

Another interviewee had this to say:

Yes, I have syllabus and textbooks just that most of the textbooks are torn. Our headteacher photocopied the syllabus for all of us but I don't have teachers' guide. I have produced charts and pasted them on the classroom walls as you can see. The pupils don't have enough textbooks. What they have is not sufficient for them unless I group them (T4).

I don't have the syllabus but I have teacher's guide and textbook. I use the textbook and the guide for lesson preparation. We have about 10 textbooks for 36 pupils. I don't have charts and other materials (T6).

Only one interviewee had the syllabus, textbooks and the teachers' guide.

Yes I have a syllabus, teachers' guide and textbooks. But all the textbooks are torn and so pupils don't have it" (T7).

Another interviewee had the syllabus, textbooks and teachers' guide without other curriculum materials.

I have syllabus, textbook and teachers' guide but we don't have materials for most of the topics (T9).

These situations are likely to have adverse effects on the implementation of the natural science curriculum especially in situations where the teachers did not have the complements of the curriculum materials.

As to whether topics in the syllabus corresponded to those in the textbooks and teachers' guide, 73.7% (171) teachers responded in the affirmative. Furthermore, 70.3% (163) of the teachers indicated that, the learning activities in the textbooks corresponded to those of the syllabus while 20.3% (47) of the teachers were not sure whether the learning activities in the textbooks corresponded to those in the syllabus. For instance, one teacher asserted that during the interview that,

I don't know whether the topics in the syllabus correspond with the ones in the textbook since I don't have any means to compare because we were not given syllabus but the office had been bringing us weekly forecast so at times we use that one (T6).

The teachers who were not sure whether the activities in the syllabus corresponded to those in the textbooks, because some of them did not have all the materials. This situation could contribute to their lack of adequate knowledge of the curriculum especially where they did not also have an Inservice training or workshop on the curriculum materials. This has implications for the implementing the natural science curriculum.

Section B: Natural science teacher's knowledge about the basic science curriculum

The results of analysis of the participant's responses to the items of section B of the questionnaire are presented in Table 4.3

Table 4.3: Natural science teachers' knowledge on the organization of the syllabus

Component	Correct Responses	Frequency	Percentage (%)
1 Number of themes of natural science syllabus	5	193	83.5
2 Identification of the themes	-		
Diversity of matter	-	198	85.3
Cycles	-	201	86.
Systems	-	200	86.2
Energy	-	200	86.2
Interactions of matter	-	195	84.1
3 Number periods for teaching natural science	6	145	62.5
4 Number of periods allocated for the teaching of theory	2	67	28.9
5 Number of periods allocated for the teaching of practical	4	96	41.4
6 Weight of profile dimension of Knowledge and Understanding	20%	118	52.2
7 Weight of profile dimension of Application of Knowledge	20%	111	49.1
8 Weight of profile dimension of Attitude and Process Skills	60%	109	48.4
9 How the profile dimensions influence teaching of natural science	Develop critical thinking skills	30	13.2
	to know pupils ability to express themselves	20	8.8
	it is in the syllabus	18	7.9
	helps to know pupils level of understanding		
	to satisfy each profile dimension	21	9.3
		24	10.6
10 Instructional approach recommended in natural science teaching	Pupils centred	114	49.1
	Teacher centred	24	10.3
	Others	94	40.5
11 Form of assessment recommended in natural science syllabus	Summative	51	22.6
	Formative	53	23.2
	SBA	128	54.2

*One participant did not provide a response.

The data presented in Table 4.3 shows that 83.5% (193) of the teachers were able to correctly give the number of themes of the natural science curriculum. Also, majority of teachers were able to name the themes of the curriculum. For example, between 84% and 86% of the teachers correctly named all the themes of the curriculum. This means that majority of teachers have knowledge of the number of themes in the natural science syllabus.

Also, about 63% (145) of the teachers successfully mentioned the number of periods allocated for teaching natural science while a good number of the teachers (71.1%, 165) and (58.2%, 135) teachers could not indicate the correct number of periods allocated to the teaching of theory and practical work respectively. This means that majority of teachers will teach without recourse to the allocation of periods for theory and practical work. Four periods out of the total of six periods per week should be allocated to practical work while the remaining periods are allocated for teaching theory.

Furthermore, with regards to the weights of the profile dimension of knowledge and comprehension, a little over half of the participants (52.2%, 118) correctly gave the weight for the dimension. Also, only 49.1% (111) of the teachers were able to provide the correct weight for application of knowledge while 48.4% (109) of the teachers gave correct weight for the profile dimension of attitude and process skills. This means that on the average, the teachers had low knowledge on the weights for profile dimensions specified for teaching, learning and testing. The implication is that, majority of the teachers are likely not to emphasize the weight of the profile dimensions in their teaching and assessment practices. The natural science syllabus dictates that, the weight of the profile dimension of knowledge and understanding should be 20%, application of knowledge, 20% and attitude and process skills 60%.

When asked how the profile dimensions influenced their teaching and assessment of natural science in the classroom, 13.3% (30) of the teachers responded that they are used to develop critical thinking skills among the pupils. Again, 7.9% (18) of the teachers said they used the profile dimensions because it is in the syllabus while 9.3% (21) of the teachers indicated that they helped them to know pupils' level of understanding of the content among others. However, the profile dimensions give a direction as to the relative emphasis that the teacher place on the teaching, learning and testing of the topics taught. Greater emphasis (60%) has been placed on "attitude and process skills" to give pupils the necessary scientific process skills to enable them build their store of scientific concepts and principles. Also, 20% emphasis has been placed on knowledge and understanding and application of knowledge respectively. The results from teachers showed that they lacked knowledge on the essence of the profile dimensions. This is likely to have serious implications for natural science teaching and assessment.

About 49% (114) of the teachers indicated that the instructional approach recommended for teaching natural science is pupil-centred approach while 10.3% (24) of the teachers said the recommended instructional approach is teacher-centred. However, about 40% (92) of teachers gave other responses such as experiments, investigation, demonstration, group work, etc as the recommended instructional approach for natural science. This means that less than half of the teachers (49%) know that the recommended instructional approach recommended for teaching natural science which is child-centred.

Finally, a little over half (54.2%, 128) of the participants indicated School Based Assessment (SBA) as the recommended assessment approach followed by formative assessment (23.2%, 53) and summative (22.6%, 51). This means a good number of natural science teachers exhibited fair knowledge of the assessment approach recommended in the curriculum. The natural science curriculum recommends the use of both formative and summative assessment procedures based on the profile dimensions. However, the SBA forms an integral part of assessment in schools and it emphasizes more on practical aspect of assessment which is expected to be administered over the term. This means that they are likely to implement the formative and summative assessments as well as the SBA effectively as outlined in the syllabus.

Results from the interview indicated that some teachers see the SBA as a form of test given to pupils and not practical assessment. For example, one participant asserted that: *I organize SBA by writing test on the board for them to answer. The SBA is okay because it helps me to know how my children are performing (T10).* Another participant claimed that:

> *Every four weeks we assess the children to find out what we have taught them how they have understood and how best they can reproduce. So the SBA is a kind of periodic assessment which helps the teacher to know how the children are progressing or retrogressing (T2).*

This means that these teachers had fair knowledge about the SBA and other assessment approaches outlined in the natural science curriculum.

Section C: Natural Science teachers' content knowledge of the natural science curriculum

This section sought to find out science teachers' content knowledge of the natural science curriculum. Teachers were asked to group the topics for the various classes under the five themes. The results of the exercise are presented in Table 4.4, 4.5 and 4.6.

Table 4.4: Natural science teachers' grouping of Primary One topics into the themes of the natural science syllabus.

Themes	Topics	Correct response	Percentage(%)
Diversity of matter	Living & non-living things	22	16.8
	Measurement	151	77.0
Cycles	Sun and Earth	54	27.6
	Day and Night	128	65.3
Systems	Simple Electronic Components	35	17.9
Energy	Sunlight	90	45.9
	Food	65	33.2
Interactions of matter	Personal Hygiene	155	79.1
	Simple machines	16	8.2

*Some respondents failed to provide responses to the items which accounts for the total respondents being less than the sample size.

The results presented in Table 4.4 indicate that only 16.8% (22) of the teachers were able to group living and non-living things under the proper theme (diversity of matter). However, 77.0% (151) of the teachers were able to group measurement under the correct theme. Also 65.3% (128) of the teachers were able to group Day and Night under the proper theme (Cycles) and only 17.9% (35) of the teachers were able to group Simple electronic components under the correct theme (Systems). Similarly, only 8.2% (16) of the teachers were able to group simple machines under the correct theme (Interactions of matter). However, 79.1% (155) of the teachers were able to group personal hygiene under the correct theme (Interactions of matter). This means that majority of the teachers had inadequate knowledge on the organization of some topics under the various themes in the syllabus.

Table 4.5: Natural science teachers' grouping of Primary Two topics in the natural science syllabus

Themes	Topics	Freq. of Correct response	Percentage(%) freq.
Diversity of matter	Living things (plants and animals)	29	15.8
	Water	4	2.2
	Air	8	4.4
	Rocks	20	10.9
	Measurement	109	59.6
Cycles	Weather conditions	163	89.6
Systems	The Human Body	99	54.4
	Parts of a plant	25.2	32.4
Energy	Hot and Cold	146	80.7
	Sound	11	6.1
Interactions of matter	Personal hygiene	21	11.6
	Sanitation	63	34.8
	Simple machines	35	19.3
	Simple electronic circuit	51	28.2

*some respondents failed to provide responses to the items which accounts for the total respondents being less than the sample.

The results presented in Table 4.5 show that only 15.8% of the teachers were able to correctly group living things under Diversity of matter. Also only 2.2%, 4.4% and 10.9% respectively were able to group water, air and rocks under diversity of matter. Also, 59.6% (109) of the teachers were able to correctly group measurement under diversity of matter. About 7% (13) of the teachers did not group any of the topics under the theme.

With regards to Systems, 89.6% (163) of the teachers were able to group weather conditions correctly under it. Also, 80.7% (146) of the teachers were able to group Hot and Cold under energy while only 6.1% (11) teachers were able to properly group sound under energy.

Also, 11.6%, 34.8%, 19.3% and 28.2% of the participants were able to correctly group personally hygiene, sanitation, simple machines and electronic circuit respectively under interactions of matter. The results indicate that majority of teachers were unable to group most topics under the appropriate theme. This showed teachers' had poor knowledge of the content of the natural science curriculum with regards to their ability to identify topics and group them under appropriate themes.

The result of primary three teacher's grouping of topics in the primary three natural science syllabus under the various themes are presented in table 4.6.

Table 4.6: Natural science teachers' grouping of Primary Three topics in the curriculum

Themes	Topics	Correct response	Percentage(%)
Diversity of matter	Soil	6	3.4
	Feeding in Plants	17	9.7
	Feeding in animals	23	13.1
	States of Matter	20	11.4
	Measurement of time	101	57.7
Cycles	Seasons	150	85.7
Systems	Sense organs	155	88.6
Energy	Waves	39	22.3
	Building simple electronic circuit	122	69.7
Interactions of matter	Personal hygiene	6	3.4
	Water pollution	7	4.0
	Water purification	143	81.7

*some respondents failed to provide responses to the items which accounts for the total respondents being less than the sample size.

Results presented in Table 4.6 indicates that 57.7% (101) of the teachers were able to correctly group measurement under diversity of matter but only 3.4% (6), 9.7% (17), 13.1% (23) and 11.4% (20) of the teachers were able to properly group soil, feeding in plants, feeding in animals and states of matter under diversity of matter respectively. This showed that except for measurement of time, greater number of teachers had poor knowledge on the topics in the primary three syllabus and therefore were unable to group them under diversity of matter. About, 86% (150) of the teachers were able to correctly group seasons under Cycles while 88.6% (155) teachers were able to correctly group Sense organs under Systems. Again, 22.3% (39) and 69.7% (122) of the teachers were able to correctly group waves and building simple electronic circuit under energy respectively.

Furthermore, 3.4% (6), 4.0% (7) and 81.7% (143) of the teachers respectively were able to correctly group personal hygiene, water purification and water pollution under interactions of matter. This means that greater number of teachers have poor knowledge on the organization of several of natural science topics under the various themes. For instance only 3.4% and 4.0% were able to group personal hygiene and water pollution respectively under interactions of matter.

The results of analysis of the participant's responses to items on the allocation of marks to aspects of SBA are presented in Table 4.7.

Table 4.7: Natural science teachers' knowledge of the guidelines for assessment and scoring of SBA

Dimensions	20%	30%	40%	50%	60%
Process	29.5(66)	64.0(103)*	12.9 (29)	6.7 (15)	4.9 (11)
Data analysis	11.6 (26)	36.2 (81)	27.7 (62)*	17.0 (38)	7.1 (16)
Conclusion	18.3 (41)	22.3 (50)*	17.4 (39)	26.3 (59)	14.7 (33)

N.B:* Expected answers

The results presented in Table 4.7 indicate that 64.0% of teacher were able to give correct percentage weight allocated to process dimension which is 30% weight while only 27.7% were able to give the percentage weight allocated to data analysis which is 40%. Also, only 22.3% of teachers were able to give the correct percentage weight allocated for conclusion which is 30%. This means greater number of teachers do not have adequate knowledge on the guidelines for scoring data analysis and conclusion components of SBA tasks. This is likely to negatively affect teachers' assessment of SBA tasks given to pupils. The weight for scoring SBA is important because it indicates the emphasis teachers should place on the various aspects for assessment of practical work given to pupils. For example, the process and attitudes should be given 30% weight, how pupils compare data and other sources of information and how they identify important information from poor information to assist in their work should be given 40% weight while ability to make conclusions should be given 30% weight.

4.3 Research question 2: What relationship exists between natural science teachers' background factors and their content knowledge of the natural science curriculum?

This research question sought to find out the relationship that existed between natural science teachers' background factors (professional, gender, academic qualification and years of teaching experience) and their content knowledge of the natural science curriculum. A Pearson Correlation analysis was run between natural science teachers' background factors and their content knowledge of the natural science curriculum. Preliminary analysis were preformed to ensure no violation of the assumptions of normality, linearity and homoscedasticity .The results are presented in Table 4,8.

Table 4.8: Pearson correlation: Relationship between natural science teachers' background factors and their content knowledge of the curriculum

Content knowledge	N	Gender	Academic qualification	Professional qualification	Number of years of teaching experience
CP1	196	-.012	-.023	.172*	.009
CP2	195	-.059	-.047	-.103	.072
CP3	195	-.020	-.047	-.119	-.065

*Correlation is significant at 0.05 level (2-tailed).CP1 = Content knowledge of primary 1 curriculum, CP2 = Content knowledge of primary 2 curriculum, CP3 = Content knowledge of primary 3 curriculum.

A slight positive relation exists between natural science teachers' professional qualification and their content knowledge of the primary one curriculum at (r = .173, n = 196, p < .05). The coefficient of determination (r^2) = .03. It therefore suggests that teachers' professional qualification accounted for about 3% of the natural science teachers' curriculum content knowledge. The coefficient of determination, (r^2)

according to Field (2009) is a measure of the amount of variability in one variable that is shared by the other. Field suggests that the r^2 value can be converted or expressed in percentage form by multiplying the coefficient of determination by 100. He however cautioned that direct conclusions about causality from a correlation based on the coefficient of determination, (r^2) value cannot be made. Generally, the result indicates that as teachers' professional qualification increases, their content knowledge of the curriculum increases.

4.4 Research question 3: What are the levels of natural science teachers' self-efficacy beliefs regarding natural science teaching?

The participant's scores obtained through the questionnaire, Natural Science Teachers' Efficacy Beliefs Instrument were used to answer the research question. Descriptive statistics were used to organize the participant's scores on the STEBI-A into mean scores and standard deviations which were used to understand the data. Mean rating of 1.0 to 1.75 represents low efficacy, 1.76 to 2.25 represents moderate efficacy, 2.26 to 3.25 represents high efficacy and 3.26 to 4.0 represents very high efficacy. This criterion was used by Shamsid-Deen and Smith (2006) and Ngman-Wara (2012) in similar studies involving pre-service science teachers. The Cronbach alpha coefficient for the whole scale and subscales were also determined. The results of the analysis are presented in Table 4.9.

Table 4.9: Mean Scores and SD of Participant's Scores for STEBI-A Scale (N =226)

Factor	Item	Mean	Std. Deviation
Factor 1			
PSTE	3	4.16	1.16
	6	4.02	1.11
	8	3.80	1.41
	17	3.59	1.12
	19	3.88	1.00
	20	2.16	1.04
	21	3.74	1.21
	23	4.08	1.09
Factor 2			
STOE	1	3.86	1.18
	4	4.08	.94
	9	3.96	1.06
	12	2.46	1.25
	11	3.95	1.04
	14	3.45	1.14
	15	3.84	.99
	16	4.04	.89

Table 4.9 presents the mean scores and standard deviations of the 16 items of the instrument. The item means scores ranged from 2.16 (SD = 1.04) to 4.16 (SD = 1.41). Apart from item 20 which has a mean of 2.6 (SD = 1.04) and item 12 with a mean of 2.46 (SD = 1.25), all the items have mean scores above the theoretical mean of the scale (3.0). The overall mean for the 16 items was 3.69 (SD = 1.10). This indicated that teachers had very high self-efficacy beliefs towards natural science teaching. Five items (3, 4, 4, 16 and 23) had mean scores above 4.0 while nine items (1, 8, 9, 11, 14, 15, 17 and 19) had mean scores between 3.26 to 4.0 indicating very high self-efficacy.

The PSTE subscale includes 8 items with mean scores ranging from 2.16 to 4.16 and an overall mean score of 3.69 (SD = 1.14). Except for item 20 which indicated moderate PSTE, natural science teachers in the Gomoa East District had very high PSTE regarding natural science teaching. That is they had the necessary skills and confidence to teach natural science effectively. The STOE subscale included 8 items with a mean scores ranging from 2.46 to 4.08 with an overall mean score of 3.70 (SD = 1.06). Except for item 12 which indicated high STOE, all items indicated very high STOE. This means that natural science teachers in the Gomoa East District had very high outcome efficacy. However, responses from the interviews indicated that some of the teachers did not have the level of efficacy towards natural science teaching indicated by the mean scores reported in Table 4.9. When some of the teachers were asked whether they would still like to teach natural science if GES were to introduce subject teaching at the lower primary level, they gave varied responses. Some of them indicated that natural science as a subject was difficult for them to teach. This is captured in the following excerpts:

Given the chance, I will not teach natural science because it is more technical and I do not have any special training in science (T10).

If they say we should do subject teaching, I would like to teach English, R.M.E and Mathematics. Natural science is sometimes difficult to teach (T5)

I will teach science to some extent because I don't understand some of the topics very well and therefore makes the subject difficult to teach sometimes (T3)

Others complained about the difficulty level of some of the topics. This is exemplified by the following excerpts:

It is very difficult to teach certain topics in natural science. For example, basic electronics. This is why I don't like science (T6).

I like teaching topics that is more practical like plants and animals. Some topics are very difficult and because we don't have materials, I find it difficult to teach them (T4).

Topics like Basic electronics are difficult for me to teach. I sometimes call the male teacher to teach those topics for me (T5).

These responses indicated that, most natural science teachers had low self-efficacy regarding natural science teaching which contradicts their responses on the STEBI instrument.

4.5 Research question 4: What are natural science teachers' instructional and assessment practices?

The research question sought to find out natural science teachers' classroom instructional and assessment practices. The data obtained through the observational guide and Part III sections A, B and C of the natural science teachers' curriculum knowledge questionnaire (NSTCK) were used to answer the research question. The results of the participant's instructional practices are presented first followed by the results on assessment practices. Descriptive statistics were used to organize the sample's responses into frequency counts and percentages.

Classroom observation was necessary in this study because there was the need to probe natural science teachers' understanding and practices of natural science teaching and assessment in actual classroom setting and also to clear discrepancies in the quantitative data. A total of ten natural science teachers were involved in the classroom observation. An inquiry-based Observational checklist developed by Bybee (1997) was adapted and used to observe each of the ten natural science teachers. A matrix of instructional and assessment practices used by natural science in the classroom was analysed and the results presented in Table 4.10.

Table 4.10: Matrix of Classroom Instructional Practices used by natural science teachers in the classroom at the introduction stage

S/N	Introduction stage	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	Total
1	States the purpose and expectations for learning	4	0	2	2	1	0	0	0	2	4	**37.5(14)**
2	Creates curiosity and gets pupils attention	4	2	2	3	1	2	0	4	0	3	**52.5(21)**
3	Raises appropriate questions	4	3	1	2	4	3	2	3	3	2	**67.5(27)**
4	Elicits responses to unearth prior knowledge	2	2	4	4	4	3	3	4	4	4	**85.0(34)**
5	Links prior knowledge to topic	3	2	3	1	2	2	1	2	0	3	**47.5(19)**
	Total percentage % (freq.)	**85 (17)**	**45 (9)**	**60 (12)**	**60 (12)**	**60 (12)**	**50 (10)**	**30 (6)**	**65 (13)**	**45 (9)**	**80 (16)**	

***Frequency in parenthesis**

Key: 0 = No Evidence, 1= Minimum Evidence, 2 = Some Evidence, 3 = Clear Evidence, 4 = Clearer Evidence

Table 4.10 shows the overall rating of natural science teachers at the introduction stage of the lesson observation. The rating ranged from 0 (no evidence) to 4 (greater evidence). The maximum frequency for each indicator was 40 and that of each participant was 20. The respondents' total percentage frequency scores on the observation schedule varied between 30% (6) and 85% (17). Respondents T10 and T1 obtained 80% (16) and 85% (17) respectively. Three respondents (T3, T4 and T5) obtained 60% (12) each. Two respondents (T2 and T9) obtained 45% (9) each on the schedule and T6 obtained 50% (10). This means that majority (about 70%) of the teachers' demonstrated high orientation toward the practice of child-centered instruction at the introduction stage of lesson delivery.

It was observed that, the overall rating of the 10 teachers on the first indicator (states the purpose and expectations for learning) was 37.5% (15). Six teachers stated the purpose and expectations of the lesson and had ratings from 1 to 4. However, four teachers did not state the purpose and expectations for learning. Also, the teachers' total percentage frequency on the second indicator (creates curiosity and gets pupils attention) was 52.5% (21). However, two teachers did not employ the second indicator during instruction. This means that, few teachers did not create curiosity to get pupils attention during natural science lessons which may adversely affect pupils' attention and participation in the lesson. Furthermore, the teachers total percentage frequency on the fourth indicator (elicits responses to unearth prior knowledge) was the highest (85%).The individual score on this indicator varied from 2(Some evidence) to 4(Greater evidence). This shows that all teachers tried to unearth what pupils already know before introducing the lessons which is an indication of effective teaching. With the exception of T9, all teachers observed showed evidence of linking prior knowledge to the topic being taught with the overall percentage frequency of 47.5%.The results in Table 4.10 therefore showed that, natural science teachers in the Gomoa East District of the Central Region generally used child-centered instructional strategies at the introduction stage of the lesson.

Table 4.11 shows the overall rating of natural science teachers at the presentation stage of the lesson observation. The rating ranged from 0 (no evidence) to 4 (greater evidence).

Table 4.11: Matrix of Classroom Instructional Practices used by natural science teachers in the classroom at the presentation stage

S/N	Presentation Stage	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	Total
1	Encourages pupils to work together	0	0	0	0	2	2	0	0	0	1	**12.5(5)**
2	Provides common experiences	3	2	2	3	2	3	3	2	1	2	**57.5(23)**
3	Encourages pupils to raise questions	0	0	0	0	4	3	0	0	2	4	**32.5(13)**
4	Asks probing questions to redirect pupils	4	4	4	4	4	3	4	4	4	4	**97.5(39)**
5	Allows time for pupils to think and respond to questions	4	4	3	3	4	3	3	4	2	3	**82.5(33)**
6	Uses a variety of materials in lesson delivery	2	4	3	3	4	2	3	4	4	1	**75(30)**
7	Divides the class for small group work	0	0	0	0	0	0	0	0	0	0	**0(0)**
8	Records pupils ideas	0	3	4	3	4	2	4	3	4	2	**72.5(29)**
9	Encourages pupils to explain their ideas in their own words	3	2	2	2	3	3	2	2	0	2	**52.5(21)**
10	Asks pupils to justify and clarify their ideas	2	2	1	0	2	0	2	1	1	2	**32.5(13)**
11	Criticizes pupils incorrect responses to questions	3	1	0	2	2	0	1	0	1	4	**30(12)**
12	Provides textbook definitions to pupils	2	3	3	1	0	0	1	4	4	1	**47.5(19)**
13	Reads notes from textbook	4	4	2	1	1	0	2	4	4	2	**60(24)**
14	Encourages pupils to interact	2	2	0	2	2	0	0	1	0	1	**25(10)**
15	Encourages pupils to use formal labels	0	3	1	2	0	0	0	2	4	1	**32.5(13)**
16	Allows time for pupils to ponder over questions	3	2	3	4	3	3	2	3	4	2	**72.5(29)**
17	Asks challenging questions	4	2	3	4	3	3	4	4	3	2	**80(32)**
18	Asks questions that allows pupils to change their minds	3	3	2	2	2	4	3	3	2	2	**65(26)**
19	Persists with pupils even when they are struggling	3	3	0	2	0	0	0	1	2	2	**32.5(13)**
20	Encourages pupils to apply concepts	0	2	0	2	0	2	2	1	0	0	**22.5(9)**
21	Reminds pupils of alternative explanations	3	3	2	4	4	3	4	4	4	3	**85(34)**
22	Refers pupils to existing data and evidence	0	1	0	2	3	2	2	2	2	3	**42.5(17)**
	Total % freq.	**51.1 (45)**	**56.8 (50)**	**39.8 (35)**	**52.3 (46)**	**55.7 (49)**	**43.2 (38)**	**47.7 (42)**	**55.7 (49)**	**54.5 (48)**	**50.0 (44)**	

***Frequency in parenthesis**

Key: 0 = No Evidence, 1= Minimum Evidence, 2 = Some Evidence, 3 = Clear

Evidence, 4 = Clearer Evidence

The maximum rating for each indicator was 40 and that of each participant was 88.The respondents' total percentage frequency scores on the observation schedule varied between 39.8% (35) and 56.8% (50). Respondents T2, T5 and T8 obtained 56.8% (50) and 55.7% (49) respectively. Respondents T9, T4 and T1 also obtained 54.5% (49), 52.3%and 51.1% respectively. Also, respondents T10 obtained 50% (44) and T7, T6 and T3 obtained 47.7% (42), 43.3% (38) and 39.8% (35) respectively on the schedule. This means that natural science teachers show some evidence of using leaner-centered instructional strategies.

The overall rating of the 10 teachers on the first indicator (encourages pupils to work together) was12.5 (5). It was also revealed that, 7 teachers (T1, T2, T3, T4, T7, T8 and T9) did not show any evidence of encouraging their pupils to work together on the other hand, the few who showed evidence on this indicator had low ratings of 1(minimum evidence) to 2(some evidence). This meant that most natural science teachers in the Gomoa East District did not encourage pupils to work together which contravenes inquiry-based teaching approach.

It was also observed that, the participants obtained 97.5% on the 4th indicator of the (Asks probing questions to redirects pupils). This meant that natural science teachers demonstrated clearer evidence of the use of questioning in their lesson presentation. Similarly, the teachers scored 82.5% on the 5th indicator (Allows time for pupils to think and respond to questions).This mean almost all the teachers allowed ample time for pupils to think and respond to questions which indicates good teaching practice.

It was further observed that no teacher divided the class into small groups (7th indicator). This means that, all teachers observed used whole class teaching and did not use small group work. Group work offers pupils the opportunity to interact with each other.

Also, teachers total percentage frequency on the 8th indicator (Records pupil's ideas) was 72.5% (29). This means that 9 teachers recorded pupils' ideas on the board. The results further indicated that, teachers scored 32.5% on the 10th indicator (Asks pupils to justify and clarify their ideas).This means that, greater number of the teachers made little effort to ask their pupils to justify and clarify their ideas. This shows that, most teachers were practicing teacher-centred approach without creating the environment for pupils to clarify their ideas.

It was also observed that, the teachers denied themselves the opportunity to detect and correct misconceptions in pupils' scientific ideas. The total percentage frequency for the 11th indicator (Criticizes pupils' incorrect responses to questions) was 30% (12). This showed some of the respondents did not criticize pupils' incorrect responses to questions which is an indication of leaner-centered instruction. This has the tendency of stifling the development of critical thinking in the pupils which has been advocated by the natural science syllabus.

It was further observed that, some of the respondents provided textbook definitions to pupils with total percentage frequency of 47.5% (19). This means some of the teachers seem to lack adequate knowledge of the content of natural science and therefore read definitions from textbooks without giving pupils the opportunity to explore and come up with their own definitions. It also indicates that some of the teachers showed some evidence of practicing teacher-centred approach. Similarly, the total score on the 13th indicator (Reads notes from textbook) was 60% (24). This showed some of the teachers practiced teacher-centred teaching approach. The respondent's total percentage frequency on the 14th indicator (encourages pupils to interact) was 25% (10).This also indicates that some of the teachers practiced teacher-centred teaching approach where pupils had little or no opportunity to interact with each other to share ideas. It was further observed that, the respondent's total percentage frequency on the 15th indicator (encourages pupils to use formal labels) was 32.5% (13).

The results in Table 4.11indicate that teachers generally showed some evidence of practicing leaner-centered instruction in their classrooms. The natural science curriculum recommends the use of inquiry-based (child-centred) approach to teaching in order to develop the necessary scientific process skills of pupils and assist them to build upon their store of scientific concepts and principles.

4.6 Natural Science Teachers Assessment Practices

This part sought to find out natural science teachers carry out assessment in their classrooms since instruction and assessment goes on simultaneously. Table 4.12 shows the percentage frequencies of natural science teachers' use of assessment strategies to evaluate their lessons. The rating ranged from 0 (no evidence) to 4 (greater evidence).

Table 4.12: Matrix of Assessment Practices used by natural science teachers in the classroom at the evaluation stage

S/N	Evaluation stage	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	Total% (f)
1	Observes pupils as they apply new concepts	2	0	0	2	2	1	0	1	0	1	**22.5(9)**
2	Compares ideas of pupils to concepts taught	2	0	0	0	1	0	2	1	0	0	**15(6)**
3	Uses different assessment techniques	1	4	4	3	3	1	3	1	4	2	**65(26)**
4	Allows pupils to assess their own learning	0	0	2	0	2	2	2	1	2	2	**32.5(13)**
5	Asks open ended questions	2	3	4	3	3	2	4	3	3	3	**75(30)**
6	Evaluates collective memory of the class	2	2	4	2	2	2	2	2	3	4	**62.5(25)**
7	Brings closure to lessons	3	4	3	4	4	4	3	3	3	3	**85(34)**
	Total % freq.	**42.9 (12)**	**46.4 (13)**	**60.7 (17)**	**50.0 (14)**	**60.7 (17)**	**42.9 (12)**	**57.1 (16)**	**42.9 (12)**	**53.6 (15)**	**53.6 (15)**	

***Frequency in parenthesis**

Key: 0 = No Evidence, 1= Minimum Evidence, 2 = Some Evidence, 3 = Clear Evidence, 4 = Greater Evidence

The maximum frequency for each indicator was 40 and that of each participant was 28. The respondents' total percentage frequency score on the observation schedule varied between 42.9% (12) and 60.7% (17). Respondents T3 and T5 obtained 60.7% (17) and respondent T7 obtained 57.1% (16). Also, two respondents (T9 and T10) obtained 53.6% (15) each. This means that five respondents showed clear evidence of using child-centred assessment techniques to evaluate their lessons. Furthermore, Respondents T4 and T2 obtained 50.0% (14) and 46.4% (13) respectively three respondents (T1, T6 and T8) obtained 42.9% (12) reach. This implies that five respondents showed some evidence of using child-centered assessment techniques to evaluate their lessons.

It was observed that, the percentage frequency of the 10 teachers on the first indicator (observes pupils as they apply new concepts) was 22.5% (9). This means that the teachers showed minimum evidence of engaging pupils to apply new concepts to their daily lives. This indicated a poor assessment practices because, the syllabus recommends that 20% weight be given to application of knowledge in assessment. Thus, pupils should be taught to develop the ability to apply rules, methods, principles and theories to concrete situations that are new and unfamiliar.

Also, the total percentage frequency of the teachers on the 2nd indicator (compares ideas of pupils to concepts taught) was 15% (6). This indicated that, the teachers showed minimum evidence of comparing pupil's ideas with concepts taught which indicated a poor assessment practices. When pupil's ideas are compared with concepts taught, the teacher creates the opportunity to identify and correct misconceptions that pupils might have.

On the otherhand, the total percentage frequency of the teachers on the 5th indicator (Asks open ended questions) was 75% (30). This indicated that the teachers showed clear evidence of using open ended to evaluate their lessons. It was also observed that, the total percentage frequency of the teachers on the 6th indicators (evaluates the collective memory of the class) was 62.5% (25). This means that, natural science teachers generally evaluated the collective memory of pupils and therefore showing showed clear evidence of evaluating the collective memory of pupils. Finally, the total percentage frequency of the teachers of the last indicator (brings closure to lessons) was 85% (34). This means that the teachers showed clearer evidence of bringing closure to their lessons. The natural science teachers generally showed some evidence of using child-centered assessment strategies to evaluate their lessons.

4.7 Section A: Design and organization of science teachers' classroom assessment task in a term

This section sought to find out when natural science teachers organize assessment in a term design assessment tasks and when they assessed pupils during natural science lessons. It also sought to find out the forms of assessment used by teachers. The results of analysis of participants' responses are presented in Tables 4.13 – 4.24.

The data in Table 4.13 indicate that all natural science teachers organized their respective assessment tasks but at different times of the term.

Table 4.13: Periods natural science teachers organize assessment in the term

Periods teachers organize assessment tasks	Frequency	Percentage (%)
Beginning of the term	11	4.8
Weekly	101	43.9
Monthly	108	47.0
Mid-term	10	4.3
Total	**230**	**100**

*Two participant did not provide a response.

The results show that, only 4.3% (10) of the teachers organized their assessment tasks at the mid-term. However, 43.9% (101) and 47.0 (108) teachers planned their assessments tasks weekly and monthly respectively. It has been recommended in the natural science curriculum that, the SBA tasks should be administered at the end of each month in the term. Apart from the SBA tasks, teachers are expected to use class exercises and home work as processes for continually evaluating pupils' performance. However, the results from the questionnaire show that, majority of teachers did not have adequate knowledge on when to organize assessment tasks in the term and this can adversely affect best assessment practices as recommended in the natural science curriculum.

The results in Table 4.14 indicate that the teachers assessed their pupils at various stages of instruction.

Table 4.14: Stages at which natural science teachers assess pupils during instruction

Stage of instruction teachers assess pupils	Frequency	Percentage (%)
Introduction stage	116	50.2
Presentation stage	61	26.3
Concluding stage	50	21.6
Throughout the lesson	4	1.7
Total	**231**	**100**

*One participant did not provide a response.

The introduction stage of instruction is the stage where half of the teachers (50.2%, 116) assessed their pupils. This is followed by the presentation stage (26.3%, 61) and the concluding stage (21.6%, 50). Only 1.7% (4) of the teachers assessed pupils throughout the lesson though the natural science curriculum recommends that assessment should be done throughout the lesson. This suggests that majority of the teachers failed to implement the recommendation.

The results in Table 4.15 indicate that the number of assessment tasks conducted by teachers within a term varied from below 10 to 40 and above.

Table 4.15: Number of assessment tasks given by teachers in a term

Number of assessment tasks	Frequency	Percentage (%)
0 – 10	20	8.6
11 – 20	51	22.0
21- 30	76	32.8
31 – 40	69	29.7
40 – above	15	6.5
Total	**231**	**100**

*One participant did not provide a response.

The results show that only 6.5% (15) of the teachers conducted assessment tasks of 40 or more while 8.6% (20) of the teachers 10 or less assessment tasks in a term. Also, about 33% of the teachers conducted between 20 and 30 assessment tasks in a term. This means that, on the average, natural science teachers conducted adequate number of assessment tasks in each term which is in consonance with the recommendations of the natural science curriculum.

The results in Table 4.16 presents the times natural science teachers design their assessment tasks.

Table 4.16: Times Natural science teachers design assessment tasks

Times assessment tasks are designed	Frequency	Percentage (%)
During lesson preparation	138	59.5
During instruction	20	8.6
After instruction	73	31.5
Total	**231**	**100**

*One participant did not provide a response.

The results indicate that, 59.5% (138) of the teachers designed their assessment tasks during lesson preparation while 8.6% (20) of the teachers design assessment tasks during instruction. Also, 31.5% (73) teachers design their assessment tasks after instruction. The results show that, quite a number of natural science teachers (31.5%) did not plan their assessment tasks appropriately. This is because designing assessment tasks should be an integral part of lesson preparation and presentation.

Table 4.17: Considerations that inform the content of teachers' assessment task

Consideration	Frequency	Percentage (%)
Content of the topic	36	15.5
Pupils knowledge level	54	23.3
Objectives of the lesson	126	54.3
Profile dimensions	6	2.6
Evaluation questions in the syllabus	9	3.9
Others	0	0.0
Total	**231**	**100**

*One participant did not provide a response.

The results in Table 4.17 indicate that as many as 54.3% (126) of the teachers considered the objectives of the lesson when developing their assessment tasks. However, 15.5% (36) and 23.3% (54) teachers have their assessment tasks based on the content of the topic and pupils' knowledge levels respectively. Also, 2.6% (6) and 3.9% (9) teacher design their assessment tasks based on profile dimension and evaluation questions in the syllabus respectively. However, it is recommended in the natural science syllabus that the content of assessment tasks should be guided by the objectives of the lesson which reflect the profile dimensions. This means that a little over half of the natural science teachers (54%) designed their assessment tasks based on the objectives of the lesson. It can be said that half of the teachers had adequate knowledge of the requirement of the syllabus with regard to designing assessment tasks while the other half did not adhere to the requirement.

The results presented in Table 4.18 indicate the types of assessment tasks teachers give to their pupils.

Table 4.18: Types of assessment tasks teachers give to their pupils

Types of assessment tasks teachers give to pupils	Frequency	Percentage (%)
Class exercises	225	97.4
Homework	220	95.2
Project work	182	79.5
Class test	218	94.4
End of term examination	214	92.6

The results presented in Table 4.18 showed that over 90% of natural science teachers gave five different types of assessment tasks to their pupils. This means that greater number of teachers gave different assessment tasks to their pupils as recommended by the natural science curriculum. However, the number of teachers who gave project work to their pupils was the lowest (about 80%). It has been recommended in the natural science syllabus that at least one project work should be given to pupils each term. This show that, about 20% of natural science teachers do not implement the SBA recommendation of the natural science syllabus with regard to project work.

Table 4.19: Range of time teachers give to pupils to complete class assignment

Range of time given by teachers	Frequency	Percentage (%)
5 – 10 minutes	23	10.0
11 – 15 minutes	42	18.2
16 – 20 minutes	63	27.3
21 – 25 minutes	31	13.4
26 – 30 minutes	39	16.9
Above 30 minutes	33	14.3
Total	**232**	**100**

The results in Table 4.19 show that 27.3% (63) of teachers gave pupils between 16 – 20 minutes to complete class assignment, 10% (23) of teachers give between 5 -10 minutes while 14.3% (33) of teachers give pupils above 30 minutes to complete class assignment. This means that natural science teachers give pupils varied time to complete their class assignments.

4.8 Types of feedback science teachers give on the tasks to their pupils

Section C of part III of the Natural Science Teachers' Curriculum Knowledge (NSTCK) questionnaire was designed to find out from natural science teachers the type of feedback they gave to their pupils and what the feedbacks were centred on. This was to help the researcher to find whether the teachers' feedback promoted learning. The results of the analysis of the participant's responses to the questionnaire items are presented in Table 4.20.

Table 4.20: Types of feedback teachers gives to pupils after assessing their work

Types of feedback given to pupils	Frequency	Percentage (%)
Oral feedback	17	7.4
Written feedback	30	13.0
Both oral and written feedback	181	78.4
Total	**232**	**100**

The results presented in Table 4.20 indicate that 78.4% (181) of the teachers gave both oral and written feedback to their pupils while 13.0% and 7.4% of the teachers gave only written and oral feedback respectively. This means that majority of teachers gave appropriate feedback to their pupils after assessing their work.

Table 4.21: Focus of natural science teacher's feedback

Focus of feedback	Frequency	Percentage (%)
Centred on praising pupils	64	27.8
Centred on task	61	26.5
Centred on both task and pupils	56	24.5
No response	51	21.2
Total	**232**	**100**

The results in Table 4.21 indicate that 27.8% (64) of teacher's feedback was centred on praising pupils, 26.5% (61) of the teachers had their feedback centred on task while 24.5% (56) of the teacher's feedback was centred on bother tasks and pupils. However, 21.2% of the teachers did not indicate the nature of their feedback to their pupils. Teachers' feedback should focus on task to ensure that, pupils who had the questions wrong could do their corrections and also to enable teachers to organize remedial lessons where necessary. However, responses of teachers indicate that, majority of them based their feedback on praising pupils while others also did not indicate what their feedback was based on. This may have negative implication for learning since proper feedback on assessment tasks is necessary to ensure that, pupils correct their mistakes and master the concepts and as well as to seek remedial lessons where necessary.

Table 4.22: Nature of task centred feedback from Natural science teachers to their pupils

Categories of responses	Frequency	Percentage (%) Freq.
Good work	62	26.8
Very Good work	54	23.5
Excellent work done	55	23.9
Do independent work	15	6.5
Check your spellings	15	6.5
Do the work again	13	5.7
No response	18	7.3
Total	**232**	**100**

Table 4.22 indicates that 26.8% of the teachers wrote 'Good work' when pupil's work was marked, 23.9% and 23.5% of the teachers wrote 'excellent work done' and 'very good respectively' while 6.5% of the teachers wrote 'do independent work' and 'check your spellings'. About 6% of teachers wrote 'do the work again' while 7.3% did not indicate the nature of their task centred feedback. The results show that majority of natural science teachers gave task centred feedback that would likely motivate pupils to work harder next time. Teachers' feedback also seeks to point errors to pupils so that they could correct them.

Table 4.23: Nature of pupil-centred feedback Natural science teachers gave to their pupils

Categories of responses	Frequency	Percentage
Keep it up	45	19.5
Good performance	61	26.5
Excellent	47	20.3
Be serious with your work	12	5.2
Other responses	31	13.4
No response	36	15.1
Total	**232**	**100**

Table 4.23 indicates that 26.5% of teachers wrote 'good performance' while 20.3% wrote 'excellent'. Also, 5.2% wrote 'be serious with your work' while 13.4% gave other responses. Again, 15.1% of teachers did not indicate the nature of pupil-centred feedback they gave to their pupils. This meant that greater number of teachers gave feedback that encouraged their pupils when they did well and also cautioned them when they performed poorly.

Table 4.24: Natural science teachers' practice of School Based Assessment (SBA)

Practice of SBA	**% and freq. of teachers' responses**				
	Always	**Very Often**	**Sometimes**	**Rarely**	**Total**
I mark as pupils work	31.9(74)	17.2(40)	39.7(92)	11.2(26)	100(232)
I allow pupils to complete their assignment and submit later	27.6(64)	20.3(47)	39.7(92)	12.5(29)	100(232)
I return their marked work the same day	61.2(142)	21.6(50)	14.7(34)	2.6(6)	100(232)
I give it out books during the subsequent lesson	24.6(57)	14.7(34)	33.2(77)	27.6(64)	100(232)
Pupils exchange and mark their own work	4.3(10)	9.1(21)	33.2(77)	53.4(124)	100(232)
How often do you give feedback?	24.2(56)	35.1(81)	35.9(83)	4.8(11)	100(232)
How often do you discuss tasks with your pupils after marking?	50.0(116)	34.5(80)	14.7(34)	9.0(2)	100(232)

*Frequency in parenthesis

Table 4.24 indicates that 31.9% (74) of the teachers always marked pupil's exercises as they are answering while 17.2% (40) of the teachers very often marked pupils work as they answered. Also, 39.7% (92) of the teachers sometimes marked pupils work as they are answering while about 11% (26) of the teachers rarely marked pupils work as they are answering.

On the otherhand, 27.6% of teachers always made their pupils to complete the assignment and to submit to them later. Also, 39.7% of the teachers sometimes made their pupils to complete work assigned to them and submit later while 12.5% of the teachers rarely made their pupils to complete work assigned to them and to submit later.

Also, 61.2% of the teachers always marked pupils' work and returned marked work to pupils on the same day while 21.6%very often, 14.7% sometimes and 2.6% rarely marked and submitted pupils work on the same day. However, 24.6% of teachers always marked and submitted pupil's work during subsequent lessons while 14.7% of them very often gave pupil's work to them during the subsequent lesson. Also, 33.2% of teachers sometimes gave pupils' work to them during subsequent lessons while 27.6% of teachers rarely gave pupils work.

In addition, while 4.3% of teachers asked pupils to exchange their work and marked on their own, 9.1% of teachers allowed pupils to exchange their work and mark. Again, 33.2% of the teachers sometimes allowed their pupils to exchange their work and mark while 53.4% of teachers rarely made their pupils to exchange their work and mark.

Also, 24.2% of the teachers indicated that they often gave feedback to pupils, 35.1% indicated that they very often gave feedback to pupils, 35.9% sometimes gave feedback to pupils while 4.8% of teachers rarely gave feedback to their pupils.

On the other hand, 50.0% of teachers always discussed tasks with pupils while 34.5% of the teachers very often discussed tasks with pupils after marking. Also, 14.7% of teachers sometimes discussed tasks with pupils after marking while 9.0% of the teachers rarely discussed feedback with pupils after marking.

The results showed that majority of the teachers gave feedback to pupils on tasks they performed. However, out of about 61% of teachers who always marked and returned pupils work on the same day, only about 50% always discussed tasks with pupils after they had marked their work. Also, since some teachers were unable to mark and return work to pupils on the same day, they preferred to give written feedback to pupils. This means that about half of the teachers do not always discuss pupils' task results with them which can adversely affect performance because pupils are able to correct their mistakes when results are discussed with them.

CHAPTER FIVE

DISCUSSION

5.0 Overview

This chapter discusses the findings of the study on natural science teachers' curriculum knowledge, self-efficacy beliefs and classroom practices. First, the findings on natural science teachers' curriculum knowledge are discussed. This is followed by discussion of the findings on the relationship between natural science teachers' background factors and their knowledge of the content of the natural science curriculum. Thirdly, the findings on natural science teachers' level of self-efficacy beliefs regarding natural science teachings are discussed and finally, the findings on natural science teachers' classroom instructional and assessment practices are discussed.

5.1 Natural science teachers' knowledge of the natural science curriculum

Teacher curriculum knowledge embraces general pedagogical knowledge, knowledge of curriculum materials, knowledge of learners, knowledge of educational context as well as knowledge of educational goals and objectives (Shulman, 1986). Teachers need to be able to effectively use knowledge from a variety of domains such as subject matter knowledge, curriculum content knowledge and pedagogical knowledge to effectively teach in their classrooms (Botha& Reddy, 2011). Teachers knowledge about materials, pedagogy and content influences their lesson preparation, delivery and evaluation (Nuangchalerm, 2011). Therefore, natural science teachers general science content knowledge, pedagogical knowledge, knowledge of curriculum materials as well as the rationale, aims and objectives of the natural science curriculum are crucial for successful implementation of the natural science curriculum.

The findings indicate that majority of teachers had the main curriculum materials such as syllabus, textbooks and teachers' guide in their schools. However, greater number of them (92.7%) did not have other supplementary teaching and learning materials. (See Table 4.2). Also, it came to light that all teachers lacked at least one curriculum material or the other in their schools which adversely affected their teaching and assessment. Furthermore, only about half of them 51.3% (119) always used curriculum materials in their lesson preparation and presentation. (See Table 4.2). This means that such teachers teach without the use of curriculum materials such as syllabus, teachers' guide and textbook. The curriculum is the key reference point for teachers, particularly in a developing country like Ghana, where it is encoded in the official textbook and teacher guides (Alexander, 2009). It therefore poses a major hindrance to effective teaching of natural science since teachers lacked these materials.

Also, about 38% (87) of teachers did not know the number of periods allocated for teaching natural science while majority of teachers (71.1%, 165 and 58.2%, 135) teachers did not know the number of periods allocated to the teaching of theory and practical respectively. This means that majority of teachers will teach without recourse to the dictates of the curriculum which states that four periods out of the total of six periods per week should be allocated to teaching practical while the remaining periods allocated for teaching theory (CRDD, 2007).

Also, about 50% of the teachers did not know the weight of profile dimensions that have been specified for teaching, learning and testing. (See Table 4.3). The natural science syllabus dictates that, the weight of the profile dimension of knowledge and understanding should be 20%, application of knowledge, 20% and attitude and process skills 60%. The implication is that, majority of the teachers are likely not to emphasize the weight of the profile dimensions in their teaching and assessment (CRDD, 2007). The profile dimensions give a direction as to the relative emphasis that the teacher should give in the teaching, learning and testing. Greater emphasis (60%) have been placed on "attitude and process skills" to give pupils the necessary scientific process skills to be able to build their store of scientific concepts and principles. Also, 20% emphasis has been placed on knowledge and understanding and application of knowledge respectively (CRDD, 2007).

Also, less than half of the teachers (49%) know the right instructional approach recommended for teaching natural science which is child-centred. The natural science curriculum emphasize enquiry processes of science instruction (CRDD, 2007). Inquiry-based instruction promotes child-centered instruction where children are actively engaged to develop scientific concepts. A good number of natural science teachers (54.2%) exhibited fair knowledge of the assessment approach recommended in the curriculum (see Table 4.3). The natural science curriculum recommends the use of both formative and summative assessment procedures based on the profile dimensions. However, the SBA forms the practical test aspect of assessment.

A greater number of teachers did not have adequate knowledge on the guidelines for scoring SBA tasks which is likely to negatively affect teachers' assessment of SBA tasks given to pupils. The weight for scoring SBA is important because it indicates the emphasis teachers should place on the various aspects of practical work given to pupils. For example, the natural science curriculum recommends that process and attitudes should be given 30% weight, how pupils compare data and other sources of information and how they identify important information from poor information to assist in their work should be given 40% weight while ability to make conclusions should be given 30% weight (CRDD, 2007).

Generally, natural science teachers in the Gomoa East District of the Central region of Ghana had not taken time to study the curriculum to know and understand its requirements and content structure (See Table 4.3). It is therefore evident from the findings that, majority of the teachers teach without adequate recourse to the requirements of the curriculum which means there is a gap between the intended and enacted natural science curriculum.

5.2 Natural Science teachers' content knowledge of the natural science curriculum

This section discussed natural science teachers' content knowledge of the natural science curriculum. Teachers were asked to group the various topics under the five themes in the syllabus. With regard to the primary one syllabus, only 16.8% of the respondents were able to group living and non-living things under the proper theme (diversity of matter) (See Table 4.4). The results showed that natural science teachers' had poor knowledge of the content of the natural science curriculum with regards to their ability to identify topics and group them under appropriate themes. Greater number of teachers have poor knowledge on the organization of natural science topics under the various themes. For instance only about 8.2% of the teachers were able to group simple machines under Interactions of matter in the primary one syllabus, about 16% of teachers were able to group living and non-living things under the diversity of matter in the primary two syllabus while only about 3.4% and 4.0% were able to group personal hygiene and water pollution respectively under interactions of in the primary three syllabus. (See Table 4.6). This confirms studies which suggest that elementary school teachers tend to have major gaps in their Science Content Knowledge and that these gaps are a major obstacle to effective teaching (Nowicki, Sullivan-Watts, Shim, Young, & Pockalny, 2013). This gap is largely as a result of poor science preparation in preservice teacher programmes and general lack of inservice continuous professional development (Diamond et, al, 2013). The inadequate content knowledge of natural science teachers can have a direct effect on pupils' learning. This implies that, teachers be incompetent in identifying and handling pupils' misconceptions and unscientific ideas.

5.3 Relationship between natural science teachers' background factors and their content knowledge of the natural science curriculum

Results from the questionnaire showed that majority of natural science teachers in the Gomoa East District at the time of this study were females (71.1%). This means that more female teachers are usually posted to the lower primary level and therefore women represent a significant majority of the teaching work force at the lower primary school level in the Gomoa East District. This confirms the findings of UNESCO (2010) that women represent a significant majority of the teaching workforce particularly in the early childhood and primary levels of education. It also came to light that all natural science teachers in the District are professionally trained and are therefore likely to have adequate knowledge of the natural science curriculum. However, only about 9% (Table 4.1) of the teachers have specialized training in science related courses such as B.Ed Science education and Agricultural science. This means that majority of natural science teachers are generalist from the colleges of education. Kathie (2010) confirmed that most primary school teachers are generalist teachers expected to deliver a diverse range of subject matter in the primary curriculum.

The results showed that a professional qualification was that only background factor which correlated positively and significantly with natural science teachers' content knowledge of the primary one curriculum (See Table 4.8). Even though correlation does not show causation, it indicates that, as teachers' professional qualification increases, their content knowledge of the curriculum increases.This findings, confirms that of Ngman-Wara (2015) who found that, professional qualification had a statically significant correlation with science teachers' knowledge of contextualized science instruction and also confirms the findings of Van Driel and Berry (2012) who stated that, curriculum content knowledge can be strengthened through teaching experience, professional development and teacher collaboration. This implies that professional qualification and continuous professional development adds to natural science teachers' curriculum knowledge base. Knowledge of content is of critical importance for teachers (Koehler & Mishra, 2008). This is because it has direct impact on teachers' ability to influence students' motivation and learning. However, there was no positive correlation between natural science teachers' content knowledge of the natural science curriculum and academic qualification and years of teaching experience as well as gender. Ngman-Wara (2015) found that, no positive relationship exist between science teachers' years of teaching experience and their knowledge of contextualized science instruction. This contradicts the findings of Harris and Sass (2011) that experience in the classroom was the only teacher factor found to improve teachers' curriculum knowledge and student achievement in elementary school. The findings means that, teachers' need to participate in professional development training workshops and in-service training programmes on natural science curriculum. These are likely to improve their content knowledge of the natural science curriculum.

5.4 Natural science teachers' self-efficacy beliefs regarding natural science teaching

Self-efficacy beliefs of natural science teachers towards science teaching were investigated. The results from the self-efficacy survey indicated a generally positive efficacy beliefs expressed by most of the natural science teachers regarding their ability to teach natural science.

The results indicates that apart from item 20 which had a mean of 2.6 ((SD = 1.04) and item 12 with a mean of 2.46 (SD = 1.25), all the items had mean scores above the theoretical mean of the scale (3.0). The overall mean for the 16 items was 3.69 (SD = 1.10). This indicates that teachers had very high self-efficacy beliefs towards natural science teaching.

The PSTE subscale had overall mean score of 3.69 (SD = 1.14). (See Table 4.9). This means that natural science teachers in the Gomoa East District had very high PSTE regarding natural science teaching. This is consistent with the findings of Bleicher (2004), Gavora (2011) and Ngman-Wara and Edem (2016).Gavora (2011) found that in-service science teachers in Slovakia had high PSTE and therefore had greater belief in their ability to facilitate learning in pupils. Ngman-Wara and Edem (2016) also found that pre-service basic Science teachers generally exhibited high self-efficacy beliefs towards science teaching. They were also found to have high PSTE. This means that natural science teachers had greater belief in their ability to teach natural science effectively.

The STOE subscale had an overall mean score of 3.70 (SD = 1.06). This indicates that natural science teachers in the Gomoa East District had high outcome efficacy. This confirms the findings of Gavora (2011), Azar (2010) and Ngman-Wara and Edem (2016). Many of the respondents confirmed that they understood natural science concepts well enough to teach natural science effectively to pupils.

However, responses from the interviews did not reflect some of the teachers' level of self-efficacy beliefs towards natural science teaching indicated by the mean scores reported in Table 4.9. They seemed generally not to be optimistic and did not believe that they were effective science teachers during the interview sessions. For instance, when some of the teachers were asked whether they would still like to teach natural science if GES were to introduce subject teaching at the lower primary level, they gave varied responses. Some of them indicated that natural science as a subject was difficult for them to teach and that they would not teach natural science when given the chance.

This is captured in the following excerpts:

Given the chance, I will not teach natural science because it is more technical and I do not have any special training in science (T10).

If they say we should do subject teaching, I would like to teach English, R.M.E and Mathematics. Natural science is sometimes difficult to teach (T5).

Others complained about the difficulty level of some of the topics. They indicated that they find it very difficult to teach certain topics in natural science. As captured by the following excerpts:

It is very difficult to teach certain topics in natural science. For example, basic electronics. This is why I don't like science (T6).

I like teaching topics that is more practical like plants and animals. Some topics are very difficult and because we don't have materials, I find it difficult to teach them (T4).

Topics like Basic electronics and are difficult for me to teach. I sometimes call the male teacher to teach those topics for me (T5).

Natural science teachers' self-efficacy beliefs are the belief teachers have about their ability to teach natural science effectively to ensure that instructional objectives are achieved. In other words, it is teacher's beliefs in their ability to influence students learning. Natural science teacher's self-efficacy belief would directly influence their performance and the performance of their pupils (Tschannen-Moran & Woolfolk Hoy, 2001). Teachers having high efficacy are more likely to use inquiry and child-centred teaching strategies, whereas teachers who have a low sense of self-efficacy are more likely to use teacher-directed strategies, such as lecture and reading from the textbook (Czerniak, 1990). Teachers who have high scores on both teaching efficacy and personal teaching efficacy would be active and assured in their responses to students and these teachers persist longer, provide a greater academic focus in the classroom and exhibit different types of feedback (Gibson & Dembo, 1984). This means natural science teachers are expected to provide greater academic focus in their classrooms. However, the results from the classroom observation show that some of the teachers (60%) were found reading from their textbooks while others provided textbook definitions (47.5%) instead of engaging pupils to explore materials and come up with their own definitions (See Table 4.11). It was evident that some of the teachers practiced teacher-centred instructional approach and exhibited low self-efficacy during instruction. This contradicts the results from the STEBI.

5.5 Natural science teachers' instructional and assessment practices

The results from the observational guide showed that majority of natural science teachers in the Gomoa East District of the Central Region generally adopted child-centred teaching practices at the introduction stage of the lesson. Teachers used previous knowledge level of their pupils as a focal point for their lessons and created the foundation for inquiry-based child-centred instructional approach.

It was observed that, the overall rating of the 10 teachers on the first indicator (states the purpose and expectations for learning) was 37.5% (See Table 4.10). Six teachers stated the purpose and expectations of the lesson and had ratings from 1 to 4. Also, the total percentage score on the second indicator was 52.5% (See table 4.10). This means that, few teachers did not create curiosity to get pupils attention during natural science lessons which may adversely affect pupils' attention and participation in the lesson. However, the total score on the fourth indicator (elicits responses to unearth prior knowledge) was 85%. Eliciting responses to unearth prior knowledge would help teachers to relate science concepts to real contexts of the pupils. This will facilitate the pupil's understanding of the science concepts. This supports the findings of Shank (2006) that, inquiry-based child-centred instruction with authentic questions generated from student's experiences is the central strategy for teaching science at the basic schools. This approach is consistent with the constructivists' view that learning is a process of building up of structures of experience where prior knowledge and experiences add to new understandings (Shank, 2006). The findings are also consistent with the recommendations of UNICEF (2014) which states that, child-centred instruction demands that lessons build on previous knowledge and skills of students.

However, at the presentation stage, majority of teachers did not encourage their pupils to work together. Also, none of the ten teachers observed divided their class small group work while six of them did not encourage their pupils to raise appropriate questions. This implies that the teachers classroom were not learner-centred. These findings are consistent with the findings of Hundeland (2011) who reported that teachers who are positive towards elements of inquiry in their teaching provided opportunity for students to work together in groups. Also, Sarikaya (2004) stated that teachers with high self-efficacy beliefs are more likely to divide the class for small group instruction as opposed to instructing the class as a whole. This means that majority of natural science teachers in the Gomoa East District exhibited low self-efficacy in their classroom instructional practices as confirmed by the observation results and contrary to the results of the STEBI questionnaire. For instance one teacher stated that, "*I will teach science to some extent because I don't understand some of the topics very well and therefore makes the subject difficult to teach sometimes" (T3).*

Also, about 30% (See Table 4.11) of the teachers criticized pupils' incorrect answer which means that few teachers used child-centred instructional approach. This confirms the views of Sarikaya (2004) that teachers with a higher sense of efficacy were more likely to criticize a student when he/she gives incorrect response. The results further showed that, majority of the teachers observed made little effort to ask their pupils to justify and clarify their ideas which suggests that they had low efficacy and practiced teacher-centred instructional approach. Sarikaya further stated that teachers with high efficacy are more likely to persist with a student in a failure situation. The results further indicated that 70% (7) teachers did not encourage pupils to work together. This result is inconsistent with the findings of Collins and O'Brien (2003) who state that, in child-centred instruction, the teacher provides pupils with the opportunities to learn independently and from one another and coaches them in the skills they need to do so effectively. It therefore suggests that most natural science teachers use more teacher-centred instructional approach as opposed to child-centred approach at the presentation stage.

It was also observed that, greater number of the teachers observed provided textbook definition to the pupils and also read notes from textbook. According to

Czerniak (1990), teachers who have a low sense of efficacy are more likely to use teacher-directed strategies, such as lecture and reading from the textbook. This means majority of natural science teachers seem to have low efficacy and inadequate content knowledge of the natural science curriculum and therefore resorted to reading notes and definitions from textbooks. Also the teachers practiced teacher-centred approach and did not engage pupils to explore materials to come up with their own definitions.

The natural science curriculum of Ghana recommends that teachers should help pupils to learn to compare, classify, analyse, look for patterns, spot relationships and draw their own conclusions (CRDD, 2007). However, majority of natural science teachers assumes primary responsibility for the communication of knowledge to students (Osei, 2004).

Also, majority of the teachers observed neither encouraged their pupils to use formal labels nor engaged them to explore materials to come up with their own findings contrary to the findings of DeJarnette (2012) that lower primary school pupils should be guided to create their own knowledge through inquiry or scaffolding interactions between teacher and child. Pierro (2015) also found that teacher self-efficacy is a critical piece in terms of understanding why teachers may not want to engage their pupils in science inquiry and hands-on activities. This means greater number of teachers observed had low efficacy.

The results showed that, greater number of teachers practiced teacher-centred instructional approach. This confirms the findings of Osei (2004) in a study which he found that most Ghanaian science teachers practiced teacher-centred instructional approach. The results also confirms the findings of Ngman-Wara (2011) and Achuonye (2015) who reported that teacher-centred instructional approach is still predominant in Ghanaian science classrooms.

The results of the observational guide and the evaluations stage showed that majority of the teachers showed little evidence of engaging pupils to apply new concepts to their daily lives which is at variance with the recommendations of the natural science curriculum. The natural science curriculum recommends that, application of knowledge includes application, analysis, synthesis and evaluation. These have been given 20% weight in natural science teaching and assessment (CRDD, 2007). Also, greater number of teachers did not compare pupils ideas with concepts taught which indicated a poor assessment practice. This means pupils may end up not verifying their own ideas with those of their colleagues and with scientific concepts.

Furthermore, greater number of teachers asked open ended questions to evaluate their lessons which indicated a good assessment approach. Also, majority of the teachers observed generally evaluated the collective memory of pupils. This confirms the view of Marriot and Lau (2008) that assessment is not just about collecting data, but is also a process used to appraise students' knowledge, understanding, abilities or skills. Also, majority of the teachers used different assessment techniques to evaluate their pupils which agrees with Stiggins (2002) who found that classroom assessment, embraces a broad spectrum of activities from constructing paper-pencil tests and performance measures, to grading, interpreting standardized test scores, communicating test results, and using assessment results in decision-making.

The results generally showed that, natural science teachers practiced formative assessment by primarily asking questions to elicit responses from pupils. However, they did not engage the pupils to apply new knowledge to their daily lives.

5.6 Natural Science teachers' implementation of SBA

The results indicate that all natural science teachers organized their respective assessment tasks but at different times of the term. For instance, 4.8% of the teachers organized their assessment at the beginning of the term while 4.3% organized their assessment at mid-term. About 44% and 47% of the teachers planned their assessments tasks weekly and monthly respectively (See Table 4.13). It has been recommended in the natural science curriculum that, the SBA tasks should be administered at the end of each month in the term while project works should be carried out throughout the term as well as end of term examinations. Apart from the SBA tasks, teachers are expected to use class exercises and home work as processes for continually evaluating pupils' performance (CRDD, 2007). However, the results from the questionnaire show that, majority of teachers did not have adequate knowledge on when to organize assessment tasks in the term and this would adversely affect best assessment practices as recommended in the natural science curriculum (See Table 4.13).

The natural science curriculum recommends that formative assessment should be carried out throughout the lesson but the responses from teachers indicate that, majority of them lacked knowledge of this recommendation and therefore restricted their assessment to specific stage of instruction with only 1.7% adhered to the recommendation of curriculum (See Table 4.14). This shows that, the assessment practiced by majority of natural science teachers is not likely to help pupils to learn (Black & William, 2009) since formative assessment does not form integral part of the teachers' instructional process.

A little over half of the natural science teachers (54.3%) had the content of their assessment tasks informed by the objectives of the lesson (Harlen, 2013) which indicated their adequate knowledge of the recommendation of the curriculum (See Table 4.17). Also, over 90% of natural science teachers gave different types of assessment tasks to their pupils which confirms the views of Zhang and Burry-Stock (2003) that classroom assessment embraces a broad spectrum of activities from constructing paper-pencil tests to project work (See Table 4.18). Also, about 80% of natural science teachers gave project work as assessment task to their pupils (See Table 4.18). This means that greater number of teachers adhered to the demands of the natural science curriculum on assessment.

About 74% of the natural science teachers gave appropriate feedback, both oral and written, to their pupils after assessing their work (See Table 4.20). This is a good practice that facilitates teaching and learning. Moss (2013) suggests that teachers' judgement of pupil achievement is central to classroom and school decisions and includes communication with pupils. The results also showed that majority of natural science teachers gave task centred feedback that motivated pupils to work harder next time and for the pupils to correct their errors (Stiggins, 2002). However, out of about 61% of teachers who always marked and returned pupils work on the same day, only about 50% always discussed tasks with pupils after they have marked been marked (See Table 4.24). Also, since some teachers were unable to mark and return work to pupils on the same day, they preferred to give written feedback to pupils. This means that about half of the teachers did not always discuss pupils' task results with them which would adversely affect performance because pupils would not be able to correct their mistakes since the results were not discussed with them (Stiggins, 2002). This would have adverse effect on teaching and learning since feedback would help the teacher to modify his/her instruction or materials or techniques and methods of teaching.

CHAPTER SIX

SUMMARY, CONCLUSION, IMPLICATIONS AND RECOMMENDATIONS

6.1 Overview

This chapter summarises the study and report major findings. It highlights the conclusions of the study and implications for practice. The implications were based on the major findings identified in the study. It further outlines some recommendations and suggestions for further research.

6.2 Summary of the study

The study explored natural science teachers' curriculum knowledge, self-efficacy beliefs and classroom instructional and assessment practices in the Gomoa East District of the Central Region of Ghana. The study also solicited the teachers' background information and their science curriculum knowledge as well as their practices of classroom instruction and assessment.

The 2007 educational reforms placed much emphasis on the study of science right from the Kindergarten level by incorporating science concepts into the environmental studies syllabus (Government of Ghana, 2002). However, (UNESCO, 2010) contends that, teachers' are usually faced with problems of adjusting to curriculum innovation especially in situations where many teachers at the lower primary level are classroom teachers who teach all subjects.

Successful implementation of the new instructional approaches outlined in the 2007 natural science curriculum means that teachers have to shift from their old ways of presenting lessons to new approaches as well as develop high self-efficacy for implementing the innovations outlined in the curriculum in their daily teaching (Azar, 2010). In order to understand natural science teachers' curriculum knowledge, self-efficacy beliefs and classroom instructional and assessment practices, the following questions were considered:

1. What is natural science teachers' content knowledge of the natural science curriculum?
2. What relationship exists between natural science teachers' background factors and their content knowledge of the natural science curriculum?
3. What are the level of natural science teachers' self-efficacy beliefs regarding natural science teaching?
4. What are natural science teachers' classroom instructional practices?

Two hundred and thirty-two natural science teachers were involved in the study. Through observation, interview and questionnaire, data were collected on natural science teachers' curriculum knowledge, self-efficacy beliefs and classroom instructional and assessment practices.

6.3 Key Findings

6.3.1 ***Research Question 1:*** What are natural science teachers' content knowledge of the natural science curriculum?

It was found in this study that majority of the teachers' knowledge of the natural science curriculum was low because majority of them did not have any form of in-service training which would have helped them acquire or deepen their knowledge about the subject matter content, pedagogy, and assessment methods required to implement an the natural science curriculum.

6.3.2 ***Research Question 2:*** What relationship exists between natural science teachers' background factors and their content knowledge of the natural science curriculum?

The Pearson Product Moment Correlation suggests only professional qualification had a slight positive correlation with natural science teachers' content knowledge of the primary one curriculum at $r = .172$ which is statistically significant at $p < .05$.

6.3.3 ***Research Question 3:*** What are the level of natural science teachers' self-efficacy beliefs regarding natural science teaching?

The PSTE subscale had overall mean score of 3.69 (SD = 1.14) while that of the STOE subscale was 3.70 (SD = 1.06). This implies that natural science teachers had a very high self-efficacy on both the PSTE and STOE sub scales. However, the interview results indicated that, some of the teachers had low self-efficacy beliefs to teach natural science.

6.3.4 ***Research Question 4:*** What are natural science teachers' classroom instructional practices?

Results from the observational guide showed that majority of natural science teachers in the Gomoa East District of the Central Region generally adopted child-centred teaching practices at the introduction stage of the lesson. However, the teachers used more teacher-centred instructional strategies for presentation and evaluation of lessons.

It was also found that majority of the teachers (98.3) restricted their assessment to specific stages of instruction and only 1.7% indicated that they assessed pupils throughout the lesson. Thus, majority of the teachers did not adequately carry out formative assessment as recommended by the natural science curriculum.

6.4 Conclusions and implication for implementing the natural science curriculum

The study explored natural science teachers' curriculum knowledge, self-efficacy beliefs regarding natural science teaching and their classroom instructional and assessment practices. The study used both quantitative and qualitative data to explore the issues of teacher knowledge and self-efficacy beliefs in-depth as well as to provide clear understanding of how natural science teachers are implementing the natural science curriculum which was a curriculum innovation introduced into the school system in 2007 by the CRDD.

The study raises pertinent issues related to the quality of teaching of natural science in the Gomoa East District of the Central region of Ghana. The study provides evidence to suggest that natural science teachers did not have adequate knowledge on the component of the natural science curriculum such as:

i. Organization of the natural science syllabus
ii. Profile dimensions
iii. Recommended instructional approaches
iv. Recommended assessment approaches

However, some of the teachers on the average adopted child-centred instructional approach, had very high self-efficacy beliefs regarding natural science teaching and used variety of assessment tools to assess their pupils as well gave appropriate feedback which will enhance learning.

In order to narrow the gap between the intended curriculum and enacted curriculum, teachers, who are the actual implementers of the curriculum need to possess adequate knowledge of the curriculum. The findings suggest that, there is a gap between the intended natural science curriculum and implemented natural science curriculum in terms of instruction and assessment.

The implication is that, teachers will distort the original intention of the developers and expectations of the curriculum will not be achieved. It is likely to have adverse effect on science education in the District.

6.5 Recommendations

Based on the findings, the researcher recommends the following:

1. The Gomoa East directorate of the Ghana Education Service should organize in-service programmes, workshops, seminars and short courses on the natural science curriculum to improve teachers' knowledge of the natural science curriculum and maintain high self-efficacy beliefs.
2. The Gomoa East directorate of the Ghana Education Service should organize in-service programmes, workshops, seminars and short courses on child-centered instructional approaches to develop teachers' competence on the use such approaches in their classrooms.
3. Ghana Education Service in the Gomoa East District should organize workshops for teachers on SBA to improve their skills and use of assessment practices.

6.6 Suggestions for further research

The findings of this study call for further research in the area of teachers' curriculum knowledge, self-efficacy beliefs and classroom instructional and assessment practices. The following are recommended for further research:

1. The researcher suggests that a similar study should be conducted in other districts in the Central Region and other regions in Ghana to evaluate implementation of the natural science curriculum which has been in existence since 2007. This will provide information on the gap between the intended and enacted natural science curriculum for teachers.

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APPENDIX A

Questionnaire for Measuring Natural Science Teachers' Curriculum Knowledge (STCK) and Assessment Practices

Introduction

Dear teachers, thank you for agreeing to participate in this study. Natural science is a new subject in the science curriculum so this study is to find out your level of natural science curriculum. The information you will provide will inform the curriculum developers of possible deficiencies in the curriculum which will guide revision of the curriculum.

Please read the following statements and kindly provide the information required. The first part seeks background information about you while the second part requires your honest opinion on natural science curriculum content. In some cases, you will be required to select the option that best describes your approach to the teaching and assessment of natural science.

Your identity will not be disclosed in the report. That is why you do not provide your name. Whatever information you will provide will remain anonymous and it will not in any way affect your status as a natural science teacher either will it be used in connection with your promotion

PART I

Background Information

Kindly provide the following either by writing or ticking at the appropriate place.

1. Sex: Male [ ] Female [ ]
2. Academic qualification
   a. SSSCE [ ] b. G.C.E Ordinary level [ ] c. G.C.E Advanced level [ ]
   b. d. Diploma [ ] e. B.Ed Science degree [ ] f. HND [ ] g. Agricultural science [ ] h. Others (specify)…………………………………………………
3. Professional qualification (s):
   a. Cert 'A' 4- year [ ] b. Cert 'A' Post Sec [ ]
   c. Diploma in Basic Education [ ]
   d. B.Ed. (Basic Education) Specialization……………

4. Number of years of teaching experience: 0 – 3 years [ ]   4 – 6 years [ ] 7- 10 years [ ] more than 10 years [ ]
5. Classes taught: Class 1 [ ]   Class 2 [ ]   Class 3 [ ]
6. In-service training (INSET) on natural science attended: Yes [ ]   No [ ]

PART II

This questionnaire is designed to elicit your honest view on natural science curriculum.

Please kindly give the responses you can. You are to answer the questions and give reasons where necessary. Tick [√] against the option chosen where applicable. Your responses will be treated confidentially and will be used only for research purposes.

Section A: Teachers' knowledge about natural science curriculum materials

7. Do you have natural science curriculum materials in your school? YES [ ]
   NO [ ]
   (If YES, go to 8)
8. Which of these Science curriculum materials do you have in your school? (Tick as many as are applicable)
   a. Syllabus [ ] b. Teachers' Guide [ ]   c. Pupils textbook [ ]
   d. Charts/Pictures [ ] e. other materials [ ]   f. none [ ]
9. Do you use science curriculum materials in lesson preparation and delivery?

   YES [ ]   NO [ ]
10. If Yes, how often do you use them? a. Sometimes [ ]   b. Often [ ]
    b. More often [ ]   d. Always [ ]
11. Do all the topics in the pupils textbook and teachers' guide correspond with the ones in the syllabus?   a. YES [ ]   b. NO [ ]   c. NOT SURE [ ]
12. Are the teaching and learning activities in the other curriculum material correspond with the ones stated in the syllabus?   a. YES [ ]   b. NO [ ]
    c. NOT SURE [ ]

Section B: Natural science teacher's knowledge about the organization of the syllabus

13. The content of the natural science syllabus are grouped into how many themes?

a. 3 b. 4 c. 5 d. 6 e. 7

14. Name the themes

……………………………………………………………………………...…

………..…………………………………………………………………………

…………………………………………………………………………………

……………………………………………………………………………………..

……………………………………………………………………………………..

……………………………………………………………………………………..

15. How many periods are stated in the syllabus for teaching natural science in the classroom within a week?

a. 3 [ ] b. 4 [ ] c. 6 [ ] d. 8 [ ] e. 10 [ ]

16. Out of the number of periods chosen in 15, how many of them is/are allocated for the teaching of:

a. Theory…………………………………………………………………………

b. Practical………………………………………………………………………

17. (a) What are the weights of the profile dimensions for teaching, learning and testing in Natural science at the lower primary (Tick under the weight of your choice)

	20%	30%	40%	50%	60%
Knowledge and Comprehension					
Application of Knowledge					
Attitude and Process Skills					

(b) How do the profile dimensions influence your teaching of natural science?

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

18. What type of instructional approach is recommended in natural science teaching?

…………………………………………………………………………………

…………………………………………………………………………………

.

19. What form of assessment is recommended in natural science syllabus?..

....

Section C: natural science teachers content knowledge of the natural science curriculum

20. Group the following Primary one Natural Science topics into the various sections as indicated in the table below: Living and non-living things, Simple Electronic components, Sun and Earth, Measurement (length, mass, volume and time), Day and Night, Personal Hygiene, Sunlight, Food, simple machines.

SECTIONS	TOPICS
DIVERSITY OF MATTER	
CYCLES	
SYSTEMS	
ENERGY	
INTERACTIONS OF MATTER	

21. Group the following Primary two Natural Science topics into the various sections indicated in the table below: Air, Personal Hygiene, Weather conditions, Hot and Cold, Living things (Plants & Animals), Sound, The Human Body, Measurement, Parts of a Plant, Water, sanitation, Rocks, simple machines (pulleys and inclined planes), simple electronic circuits.

SECTIONS	TOPICS
DIVERSITY OF MATTER	
CYCLES	
SYSTEMS	
ENERGY	
INTERACTIONS OF MATTER	

22. Group the following Primary three Natural Science topics into the various sections indicated in the table below: Seasons, Soil, Waves, Feeding in Plants, Feeding in Animals, Sense organs, States of Matter, Personal Hygiene, Water purification, Measurement of Time, Building Simple Electronic circuit, Water pollution.

SECTIONS	TOPICS
DIVERSITY OF MATTER	
CYCLES	
SYSTEMS	
ENERGY	
INTERACTIONS OF MATTER	

Part III

This questionnaire is designed to elicit your honest view on assessment practices during natural science lessons. Please kindly give your best responses as possible. Please tick your answer and give reasons where possible. Your objectivity and truthfulness is highly required. Thank you.

Section A: Teachers' classroom assessment organization

23. When in the term do you organize assessment?

Beginning of the term [ ]   Weekly [ ]   Monthly [ ]   At the middle of the term [ ]

24. At what stage of instruction do you assess your pupils?

Introduction stage [ ] presentation stage [ ] concluding stage [ ] (Tick as many as apply to you)

25. On the average, how many assessment tasks do you give to your pupils in a term?

a. 0 – 10 [ ]   b. 11 – 20 [ ]   c. 21 – 30 [ ]   d. 31 – 40 [ ]   e. 40 and above [ ]

26. When do you often design your assessment tasks?

During lesson preparation [ ]   During instruction [ ]   After instruction [ ]

27. What informs you about the type of assessment tasks you design in (38) above?

a. Content of the topic [ ]   b. Pupils knowledge level [ ]   c. objectives of the lesson [ ]

d. profile dimensions [ ]   e. evaluation questions in the syllabus [ ]   f. Others_______________

Section B: Type of tasks science teachers give to their students

28. What type of assessment do you give to your pupils?

(Please tick as many as are applicable)

(i) Class exercise [ ] (ii) Homework [ ] (iii) Project work [ ] (iv) class test [ ]

(v) End of term exams [ ]

29. How often do you give the assessment you have ticked in (i – v)

(State the number of times in a term)

(i) Class exercise……….. (ii) Homework……… (iii) Project work……….. (iv) Class test………… (v) End of term exams …………

30. (a) What are the guidelines for assessment and marking of School-Based Assessment (SBA)? (Tick under the weight of your choice)

	20%	30%	40%	50%	60%
Process					
Data analysis					
Conclusion					

31. How much time do you give your pupils to complete class assignment?
a. 5 – 10 mins [ ] b. 11 – 15 mins [ ] c. 16 – 20 mins [ ] d. 21 – 25 mins [ ] e. 36 – 30 mins [ ] f. above 30 mins [ ]

Section C: Type of feedback science teachers give on the task of their pupils

32. What type of feedback do you give to your pupils after marking their work?
Oral feedback [ ] Written Feedback [ ] Both oral and written feedback [ ]

33. What does your feedback centre on?

(Does it consist of statements of praise or statement on pupils' task)…………………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………

34. Give two examples of feedback centred on task…………………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………

35. Give two examples of feedback centred on pupils…………………………-
…………………………………………………………………………………
…………………………………………………………………………………
………………………………………………………………………………..

36. Please tick the column that describes the statement in the table

ITEMS	OPTIONS			
	Always	Very Often	Sometimes	Rarely
I mark pupils' assignments during instruction as they work				
I allow pupils to complete their assignment and submit later				
I mark pupils' assignment and return their marked work the same day				
I mark pupils' assignment and give it to them during the subsequent lesson				
At the end of their assignment, I ask pupils to exchange and mark their own exercise during class as I go round to supervise them				
How do they respond to feedback you give to pupils				
How often do you discuss tasks with your pupils after marking?				

APPENDIX B

QUESTIONNAIRE FOR MEASURING NATURAL SCIENCE TEACHERS' SELF-EFFICACY BELIEF REGARDING SCIENCE TEACHING

Dear Teacher,

Thank you for agreeing to take part in this study. The purpose of the study is to explore your ideas about natural science curriculum and beliefs about teaching natural science and your classroom practices. It is hoped that the information you provide will help address the challenges that confront you as implementer of the curriculum.

SECTION A

Background Information

Please, tick [√] the appropriate box [   ] or column; or write in the blank spaces where necessary

37. Sex: Male [ ] Female [ ]
38. Academic qualification
    e. SSSCE [ ] b. G.C.E Ordinary level [ ] c. G.C.E Advanced level [ ]
    f. d. Diploma [ ] e. B.Ed Science degree [ ] f. HND [ ] g. Agricultural science [ ] h. Others (specify)…………………………………………………
39. Professional qualification (s):
    b. Cert 'A' 4- year [ ] b. Cert 'A' Post Sec [ ]
    g. Diploma in Basic Education [ ]
    h. B.Ed. (Basic Education) Specialization……………….
    i. Others (specify)--
40. Number of years of teaching experience: a. 0 – 3 years [ ] b. 4 – 6 years [ ] c. 7-10 years [ ] d. more than 10 years [ ]
41. Classes taught: Class 1 [ ] Class 2 [ ] Class 3 [ ]
42. In-service training (INSET) on natural science attended: Yes [ ] No [ ]

SECTION B

Please respond to all items given below by putting a tick [√] in the appropriate space using the following scale: 1 = Strongly Disagree, 2 = Disagree, 3 = Uncertain, 4 = Agree and 5 = Strongly Agree

S/N	Statement	SD	D	UN	A	SA
1	When a pupil does better than usual in natural science, it is often because the teacher exerted a little extra effort.					
2	I will continually find better ways to teach natural science					
3	Even if I try very hard, I will not teach natural science as well as I will teach most subjects					
4	When the natural science marks and grades of pupils improve, it is often because I have found a more effective teaching approach.					
5	I know the steps necessary to teach natural science concepts effectively					
6	I will not be very effective in monitoring natural science practical activities in class.					
7	If pupils are underachieving in natural science, it is most likely due to ineffective natural science teaching.					
8	I will generally teach natural science ineffectively					
9	The inadequacy of a student's natural science background can be overcome by good teaching					
10	The low natural science achievement of some pupils cannot generally be blamed on their teachers					
11	When a low-achieving pupil progresses in natural science, it is usually due to extra attention given by the teacher					
12	I understand natural science concepts well enough to be effective in teaching natural science.					
13	Increased effort in natural science teaching produces little change in some pupils' natural science achievement					
14	The teacher is generally responsible for the achievement of pupils in natural science					
15	Pupils' achievement is directly related to their teacher's effectiveness in natural science teaching					
16	If parents comment that their child is showing more interest in natural science at school, it is probably due to the performance of the child's teacher.					
17	I find it difficult to explain to pupils why natural science experiments work					
18	I will typically be able to answer pupils' natural science					

	questions during lessons.					
19	I wonder if I have the necessary skills to teach natural science					
20	Given a choice, I will not invite the headteacher to evaluate my natural science teaching					
21	When a pupil has difficulty understanding a natural science concept, I will usually be at a loss as to how to help the pupil understand it better					
22	When teaching natural science, I will usually welcome pupils' questions					
23	I do not know what to do to encourage pupils to learn natural science					

APPENDIX C

OBSERVATION SCHEDULE FOR NATURAL SCIENCE TEACHERS' CLASSROOM INSTRUCTIONAL PRACTICES

Stage of instruction	Inquiry stages	Teacher behavior	Frequency	Percentage score
Introduction	Engagement	1. States the purpose and expectations for learning 2. Creates curiosity and gets pupils attention 3. Raises appropriate questions 4. Elicits responses to unearth prior knowledge 5. Links prior knowledge to topic		
Presentation	Exploration	6. Encourages pupils to work together 7. Provides common experiences 8. Encourages pupils to raise questions 9. Asks probing questions to redirect pupils 10. Allows time for pupils to think and respond to questions 11. Uses a variety of materials in lesson delivery 12. Divides the class for small group work		
	Explanation	13. Records pupils ideas 14. Encourages pupils to explain their ideas in their own words 15. Asks pupils to justify and clarify their ideas 16. Criticizes pupils incorrect responses to questions 17. Provides textbook definitions to pupils 18. Reads notes from textbook 19. Encourages pupils to interact 20. Encourages pupils to use formal labels		
	Extension	21. Allows time for pupils to ponder over questions 22. Asks challenging questions 23. Asks questions that allows pupils to change their minds 24. Persists with pupils even when they are struggling 25. Encourages pupils to apply		

		concepts 26. Reminds pupils of alternative explanations 27. Refers pupils to existing data and evidence		
Evaluation	Evaluate	28. Observes pupils as they apply new concepts 29. Compares ideas of pupils to concepts taught 30. Uses different assessment techniques 31. Allows pupils to assess their own learning 32. Asks open ended questions 33. Evaluates collective memory of the class 34. Brings closure to lessons		

APPENDIX D

INTERVIEW GUIDE FOR NATURAL SCIENCE TEACHERS' CURRICULUM KNOWLEDGE CLASSROOM INSTRUCTIONAL PRACTICES

Part I

Bio data:

1. Sex:
2. Academic qualification:
3. Professional qualification:
4. Classes taught:
5. Years of teaching:
6. INSET:

Part II

1. What is the rational for teaching science in the lower primary?
2. How does it help in your teaching and assessment?
3. Do you have curriculum materials in your school?
4. How do teachers who do not have curriculum materials prepare their lessons?
5. Why do you think some teachers who have curriculum materials wouldn't use it in their lesson preparation and presentation?
6. Tell me about the SBA
7. Do you think the SBA guidelines are helpful to you as a teacher?

8. Which topics do you find difficult to teach?
9. Please give reasons
10. Which topics do you teach with ease?
    Please give reasons
11. Do you feel confident about science teaching?
12. Given the opportunity, will you continue teaching natural science?
13. If YES, why? And if NO, why?
14. What do you think should be done to improve the teaching of natural science?
15. What do you think GES should add or take from the natural science syllabus?
16. What should be done to improve the natural science syllabus?

APPENDIX F

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.732
Bartlett's Test of Sphericity	Approx. Chi-Square	917.413
	Df	253
	Sig.	.000

APPENDIX G

ROTATED COMPONENT MATRIX

Rotated Component Matrix[a]

	Component 1	Component 2
If parents comment that their child is showing more interest in natural science at school, it is probably due to the performance of the child's teacher.	.691	
When a low-achieving pupil progresses in natural science, it is usually due to extra attention given by the teacher	.587	
The teacher is generally responsible for the achievement of pupils in natural science	.573	
Pupils' achievement is directly related to their teacher's effectiveness in natural science teaching	.556	
When teaching natural science, I will usually welcome pupils' questions	.535	
When the natural science marks and grades of pupils improve, it is often because I have found a more effective teaching approach.	.477	

I will typically be able to answer pupils' natural science questions during lessons.	.471		
The inadequacy of a student's natural science background can be overcome by good teaching	.468		
When a pupil does better than usual in natural science, it is often because the teacher exerted a little extra effort.	.466		
I know the steps necessary to teach natural science concepts effectively	.438		
The low natural science achievement of some pupils cannot generally be blamed on their teachers	-.431		
I will continually find better ways to teach natural science	.424		
I understand natural science concepts well enough to be effective in teaching natural science.	.420		
I will not be very effective in monitoring natural science practical activities in class.		.625	
When a pupil has difficulty understanding a natural science concept, I will usually be at a loss as to how to help the pupil understand it better			.589

Even if I try very hard, I will not teach natural science as well as I will teach most subjects	.563
I wonder if I have the necessary skills to teach natural science	.561
I find it difficult to explain to pupils why natural science experiments work	.526
I do not know what to do to encourage pupils to natural science	.480
I will generally teach natural science ineffectively	.475
Given a choice, I will not invite the headteacher to evaluate my natural science teaching	-.376
If pupils are underachieving in natural science, it is most likely due to ineffective natural science teaching.	
Increased effort in natural science teaching produces little change in some pupils' natural science achievement	

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.