UNIVERSITY OF EDUCATION, WINNEBA

IMPLEMENTATION OF THE SENIOR HIGH SCHOOL BIOLOGY CURRICULUM: A STUDY OF CURRICULUM INTENTIONS AND CLASSROOM PRACTICE IN THE CENTRAL REGION OF GHANA

JOHN EKOW MBIR AMOAH

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A Thesis in the Department of SCIENCE EDUCATION, Faculty of SCIENCE EDUCATION, submitted to the School of Graduate Studies, University of Education, Winneba in partial fulfilment of the requirements for the award of

DOCTOR OF PHILOSOPHY IN SCIENCE EDUCATION

SEPTEMBER, 2018

DECLARATION

Candidate's Declaration

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

SIGNATURE:…………………………………

DATE: …………………………………………

Supervisors Declaration

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

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DEDICATION

This project is dedicated to God, who helped and sustained me during this thesis. Also to the memory of my late father, Class Peter Kojo Fuah Amoah, Mr. Magnus Rex Danquah, my mum, Elizabeth Ofori-Attah, wife, Helena, son, Peter Donald and daughters, Elizabeth, Kate-Lillian and Angela not forgetting family members whose unflinching support and prayers saw me through.

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ABBREVIATIONS AND ACRONYMS

B.Ed.	-	Bachelor of Education
B.Sc.	-	Bachelor of Science
CRDD	-	Curriculum Research and Development Division.
GAST	-	Ghana Association of Science Teachers
GES	-	Ghana Education Service
M.Ed.	-	Master of Education
MOE	-	Ministry of Education
MOESS	-	Ministry of Education Science and Sports
M.Phil.	-	Master of Philosophy
PGDE	-	Post Graduate Diploma in Education
SMT	-	Science, Mathematics and Technology
SMTE	-	Science, Mathematics, Technology and Engineering
STMIE	-	Science, Mathematics, Technology, Innovation and Engineering
SHS	-	Senior High School
SSS	-	Senior Secondary School
WAEC	-	West African Examinations Council
WASSCE	-	West African Secondary School Certificate Examinations

ABSTRACT

This study evaluated the classroom implementation of the Senior High School elective biology curriculum in the Central Region of Ghana. A cross-sectional descriptive survey design was used for the study. Three instruments were designed and validated for data collection; these were (i) Questionnaire (ii) Interview (iii) Observation Instrument (Barbados Workshop Instrument) as the main instrument for the study. The target population comprised all the public Senior High Schools in the Central Region of Ghana that offered elective biology. The accessible population however consisted of 58 public Senior High Schools out of which 21 schools were selected making up 36% of the accessible population. The schools were categorised as Grade A, B and C schools based on GES standards. The schools were selected through stratified random sampling from these districts and municipalities in the region; Abura-Asebu-Kwamankese, Assin North, Assin South, Cape Coast, Efutu, Ekumfi, Komenda-Edina-Eguafo-Abrem, Mfantseman, and Upper Denkyira East. Form two biology teachers and students were selected as respondents for the study. Student respondents were selected through random sampling in single sex schools and stratified random sampling in mixed schools. Microsoft Excel and The Statistical Package for Social Sciences (SPSS version 22.0) were used by the researcher to analyse the data. Descriptive statistics was used to analyse and answer research questions 1, 4, 5 and 6. Factor analyses was also used to perform inferential analysis and to draw conclusions on research questions 2 and 3. The results revealed that all teachers in grade A schools were academically and professionally qualified to teach biology whilst 22.65% in grade B schools, and 9.43% in grade C schools however, were not professionally qualified to teach biology at the Senior High School. Resources for teaching and learning biology were also inadequate in all the categories of schools visited. A high proportion of teacher respondents thus 77.36% agreed that they had challenges with their teaching functions and this did not also reflect enough cognitive and process skills in their instructional activities. Over 90% of teachers also did not organise practical activities regularly and this was affecting some profile dimensions as suggested by the teaching syllabus. It was recommended that professionally and academically qualified biology teachers in the Central Region should be evenly distributed so that they would not be concentrated in only a few schools while others lacked them. Also only qualified and experienced teachers should handle Senior High School students in order to build a good and strong foundation for the students. Among other recommendations made were that schools should employ qualified laboratory technicians to assist biology teachers in organising practical activities, regular support and capacity enhancing activities should be organised to augment teachers‟ pedagogical skills and also imprests should be given regularly to teachers in order to organise weekly practical activities as suggested by the biology curriculum. Based on the findings of this study, it was suggested that a study should be conducted to investigate the classroom implementation of the Senior High School biology curriculum in other regions of Ghana. Also another study should be conducted to investigate the professional competence of Senior High School biology teachers in selected schools.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter presents the background to the study about the problem, which led to the statement of the problem. It continues with purpose of the study, as well as the research objectives and research questions of the study. The significance, delimitations, limitations and definition of terms were also looked at. The chapter ends with organisation of the study.

1.1 Background to the Study

Science education is very important to the development of any nation. The advances in science and technology have influenced the rate of economic development of nations, improved the quality of life in most parts of the world, and provided solutions to some major problems and needs of societies (Anderson, 2007). The impact of science and technology is felt on education, health, nutrition, transport and communication. Our continued existence depends on our ability to harness scientific and technological knowledge to solve practical human problems.

In view of this, Ghana has made science a core component of the school curriculum, which would produce scientific literate citizens, who can make informed choices in their personal lives and approach challenges in the workplace in a systematic and logical order. They also need to become competent professionals in the various scientific disciplines, who can carry out research and development at the highest level.

The biology curriculum has been designed to help students solve basic problems within their immediate environment through analysis and experimentation, develop scientific approach to solving personal and societal (environmental, economic and health) problems (Ministry of Education, 2010).

The general aims of the biology curriculum are to help students to appreciate the diversity of living things, understand the structure and functions of living things, develop scientific approach to solving personal and societal (environmental, economic and health) problems (Ministry of Education, 2010). In addition to that, the curriculum was to help students to develop practical skills required to work with scientific equipment, biological materials and living things, collect, analyse and interpret biological data; and also present data graphically (Ministry of Education, 2010). More so, students were to be aware of the existence of interrelationships between biology and other scientific disciplines and sustain their interest in studying biology. Again, students were to appreciate and understand the interrelationships between organisms and themselves, and with the environment. Students were to recognize the value of biology to society and use it responsibly to develop a sense of curiosity, creativity and critical mindedness as well as providing a foundation for those who will develop a career in the biological sciences (Ministry of Education, 2010).

There were also suggestions for teaching the biology curriculum in the Senior High Schools. The teaching of biology was to be student-centred and activity oriented. The teacher was to act as a facilitator. For effective teaching and learning in this course, it is recommended that the school should establish a small botanical garden, animals in a cage, fishpond and insects in a cage. Video clips could also be shown where these are available. Again, it is important that classroom teaching be supplemented with field trips wherever appropriate. The provision of well-equipped laboratories would enhance teaching and learning biology (Ministry of Education, 2010).

Teachers" involvement in the curriculum implementation process is essential in meeting the needs of society. The process of curriculum implementation requires teachers to act and reflect on society's needs in each stage of the development process (Kumabia, 2014). Nevertheless, sometimes this process which teachers are requested to follow is unclear. For example, in Ghana most teachers were not qualified and lacked the necessary skills to participate in curriculum implementation and development. Their approach of participation in the process was not well defined and very difficult on teachers, so they faced many challenges regarding their involvement in curriculum implementation (Ahorlu, 2013). As a result, there should be major advances in teacher development in order for teachers to actively reflect on society's needs in each stage of the curriculum implementation process. Professional development of teachers is an important factor contributing to the success of a curriculum (Handler, 2010).

It is important that a teacher thoroughly understands a subject in order to teach it effectively. This idea is aptly expressed by Murray (1986), who stated that the teacher's role was to find and present the most powerful and generative ideas of a discipline. This implies that a teacher comprehends the structure of the discipline, its key points and their origins, the criteria by which one distinguishes the important from the trivial. This kind of understanding, slighted in traditional programmes, is of fundamental importance to the teacher-and must have a central place in the teacher's education. He further stated that, "the traditional major often does not confer a level of understanding that empowers the teacher (or even the typical college graduate) to understand" (Murray, 1986 pp.16-25).

Teaching is the main way of promoting learning and achievement among students but teaching and learning are what affect knowledge, skills, attitudes, and the capacity of young people to contribute to contemporary societies (Mangal, 2007). The approach used by teachers is very important to the success of the teaching process. Teachers should learn how to use several teaching methods. No one method of instruction would work all of the time and under every circumstance. Thus, the selection of a teaching method is critical to the learning style of those being served by instruction. Students‟ questions are as important as teachers‟ questions. There are times when the teacher must show, demonstrate and explain in lesson delivery.

Teaching, as an intellectual activity should include knowledge, linking content and methodology, and sentences (Cadenhead, 1985). This statement suggests that a quality teacher-education programme in biology should include courses in biology content, scientific methods, general education, and liberal studies.

There are many challenges faced in the teaching and learning of science subjects in schools. Kola (2013), stated that science teachers are important in the teaching and learning of science, and there is no development of science education in any country without considering teachers‟ contribution. There are shortages of qualified science teachers in some African countries, and in some instances, teachers available to teach science may not be qualified to teach the subject (Muwanga-Zake, 2001). If teachers have problems in understanding some of the topics in the subjects that they teach, it raises concerns around their content knowledge (Ramnarain & Fortus, 2013). Ogunniyi and Rollnick (2015) noted the problem of the existence of unqualified science teachers in schools in Africa, and how this negatively affects quality science teaching and learning. However, all these challenges also occur vividly in the Ghanaian context (Ackon, 2014).

The Senior High School biology syllabus from WAEC emphasises the acquisition of scientific skills (e.g. Accurate observation, measurement, and recording), laboratory skills as well as scientific attitudes (e.g. Concern for accuracy, objectivity, integrity, initiative etc.). It is therefore expected that students would go through a science curriculum, which include practical work in preparation for the final WAEC science practical examinations. However, a variety of specific students‟ weaknesses in the practical examinations reported by Chief Examiners cast serious doubts on Senior High School students‟ involvement in practical activities in the schools. This gives the impression that students are either not taken through practical activities or did not take them seriously. Some of the persistent weaknesses identified over the years (2000-2015) by the Chief Examiners for the sciences are as follows:

Biology:

i. technical terms were wrongly spelt, and also failure to adhere to the convention of writing scientific names.
ii. candidates were incapable of critical analysis and interpretation of biological data.
iii. candidates should be given sufficient tutorials and assignments on concise and accurate answers as well as going through rubrics and comprehension of the subject.
iv. candidates are not having adequate practical work as shown by the answers been provided.

All these instances are happening, despite the fact that science teaching materials have been distributed to all Senior High Schools (Ministry of Education, 2012) to serve as teaching aids to supplement existing resources in the Senior High Schools. This was intended to give ample opportunities for practical work by students using modern facilities and techniques including the use of computers.

The importance of laboratory apparatus, in teaching and learning of science cannot be overemphasised. Learners" involvement in practical activities in the laboratories assists them to better understand scientific processes. In a laboratory with the relevant material and equipment, learners are provided with the chance to actively learn science, which is by nature investigative (Tobin, 1990).

The importance of learners" active involvement in science learned is further emphasised by Osborne and Collins (2000), who argued that learners construct meaningful scientific knowledge and investigative processes by being actively involved in science knowledge construction. Similarly, Orji (2006) noted that the availability and proper use of relevant materials, such as library materials and science laboratory equipment have positive influence on learner performance and ultimate attainment.

Class size is an important factor with respect to academic performance of students. There is consensus among researchers and educational scholars that students" achievement decreases as class size increases (Babatunde & Olanrewaju, 2014). Similarly, overcrowding in a classroom made it complicated for teachers to manage each individual"s attention and also make use of various teaching and assessment methods (Morrow, 2007). Mitchener and Anderson (1989), highlighted the teachers" concerns regarding losing class control as the cause for their passive resistance to role changes. For instance, teachers feel uncomfortable with the facilitator role compared to their traditional lecturer-expert role (Ackon, 2014).

Years of teaching experience were reported by Lederman (1999), to cause clear differences between the classroom practices of teachers. The results of his study indicated that experienced teachers (14 and 15 years of experience) exhibited classroom practices consistent with their professed views about the nature of science: they included many inquiry oriented activities (i.e., demonstration and laboratory practices) that required students to collect data, and infer explanations from the data that had been collected. Novice teachers, with less than 5 years of experience, struggled to develop an overall organizational plan for their courses and were a bit frustrated by the discrepancy between what they wanted to accomplish and what they were capable of accomplishing with their students (Effah, 2014).

The aim of this current study was to provide a knowledge base for policy-makers and teacher educators on the classroom implementation of the Senior High School biology curriculum, which has been in use since, the 2010/2011 academic year. This study sought to shed light on how to make biology teaching and learning effective. This may facilitate the proper implementation of the biology curriculum, and help policy-makers and teachers to update it, in line with students‟ learning needs. Additionally, teachers could see their weak and strong areas regarding teaching biology.

1.2 Statement of the Problem

Education reform initiatives of the last twenty years have impacted very little on students‟ performance in science and in biology to be precise. The main reason was that too little attention has been paid to what actually goes on in the classroom (Anamuah-Mensah, Mereku, & Ampiah, 2009).

Although Ghanaian schools have a good number of quality teachers, there are others who scarcely apply the teaching methods and psychological principles, they have learnt in the Colleges of Education and Universities. This is to recognize and make use of individual differences, interests, abilities and needs of students in a way to help them develop their talents and potentialities. Some teachers do not provide opportunities for independent critical thought with emphasis on freedom of expression and open-mindedness (Dzieketey, 2010; Ahorlu, 2013). Those teachers bow to the pressure of preparing students to pass competitive academic examinations by resorting to cramming students with pre-digested information, and thereby encouraging passive learning and rote memorization.

Because teachers are the overriding factor they should be willing to use, interpret and implement the curriculum as prescribed. The West African Examinations Council (WAEC) Chief Examiners Reports of the years (2000-2015) in Ghana revealed fluctuations and downward trends in students" performance. The general comments on biology stated that "the standard of the paper compared favourably with that of previous years but candidates" performance was far from satisfactory" [p.1]. Some teachers are therefore not adhering to the recommended teaching approaches as directed by the curriculum.

Biology, as one of the elective science subjects in Senior High Schools, is a very popular subject considering the massive, enrollment it enjoys in Ghana relative to the other science subjects. Hence, an encouragement to learn biology especially at the Senior High School (SHS) level is of paramount importance. Practical work constitutes an integral part of biology. Kankam (2013), stated that practical work helps students to learn various skills, and gives students a sense of achievement, when they themselves make discoveries, and arrive at scientific conclusion through their own experiments. Instructional resources are inevitable in the teaching of practical skills in biology. It makes teaching and learning more meaningful and real.

Numerous reasons have been identified in the literature to be the underlying causes of the poor performances of Senior High School elective biology students. Some of these are that, students saw the subject as difficult, which according to

Abdul- Mumuni (1995), and Lakpini (2007), was influenced by their religious, social and cultural backgrounds. Some students perceived biology as a difficult subject that involved so much reading which made it difficult for them (Mucherah, 2008). Again, Shaibu and Olarewaju (2007), noted that misconceptions students hold about some of the biology topics, such as genetics and evolution also affect their understanding of the subject. Finally, poor teaching methods employed by some teachers also influenced students" performance in the subject (Mucherah, 2008).

A number of factors have been identified to be responsible for the poor performances in science from the various studies conducted in Ghana. These include the lack of motivation for most teachers, poor infrastructural facilities, inadequate textual materials, and attitude of students to learning and lack of teaching skills (Acquah, Adzifome & Afful-Broni, (2013). In addition to that, competence by science teachers and lack of opportunities for professional development for science teachers (Saribas & Bayram, 2009). Other studies reported that poor classroom organisation, lack of management techniques, and poorly co-ordinated student activities also reduced the quality of science teaching and learning (Akale & Nwankwonta, 1996). Ameyaw-Akumfi (n.d), Akyeampong, (2003) and Riske (2007), also found the shortage of funds for equipment and materials for fruitful practical work; especially in view of large class size in most schools was a problem. Some other researchers also attributed the low percentage of students, who passed examinations in science, to dissatisfaction with the syllabus, teachers" qualifications, workload, experience and disposition, general lack of teaching skills, and the ineffective style of delivery of subject matter (Salau, 1996; Garret, Birman, Porter, DeSimone, Herman, and Yoon, 1999). All these studies dealt with science, however this study wanted to have a holistic evaluation of the biology curriculum in Senior High Schools in Ghana.

Soyibo (1992), in his own view stated that the teachers attributed poor performance of biology students in schools to improper utilization of laboratory equipment. The studies by Awoyele (1992), Banu (1994), and Ahorlu (2013), have shown that lack of adequate supply of science equipment and improper management and utilisation of available equipment in teaching is what leads to the low achievement in science. Also, studies in Ghana by Dzieketey (2010) and Ahorlu (2013), focused on problems encountered during practical lessons in integrated science and biology respectively. Shortage of instructional resources in our Senior High Schools was not new. What seems to be the practice is that some teachers have not been able to utilize the available resources and by implication, these resources were wasted (Ahorlu, 2013).

Though substantial research works in science education in the past 20 to 30 years have been on students‟ achievements and learning towards science, little has focused on a particular science discipline like biology, chemistry or physics (Osborne, Simon & Collins, 2003). No researcher in the Central Region of Ghana has reportedly given a comprehensive evaluation of the entire Senior High School biology curriculum and the extent to which these suggestions are being implemented in the classrooms and laboratories. Hitherto that, the last time the Senior High School curriculum was evaluated was in the 2010/2011 academic year.

It would therefore be desirable; to evaluate the classroom implementation of Senior High School biology curriculum in the Central Region of Ghana, in order to help shed some light on what may be happening in the various classrooms and schools in the hope of promoting the teaching and learning of biology according to the curriculum prescriptions.

1.3 Purpose of the Study

The purpose of this study was to evaluate the classroom implementation of biology curriculum in selected Senior High Schools in the Central Region of Ghana.

1.4 Objectives of the Study

The objectives of the study were to find out;

1. the academic and professional qualifications, and the areas of specialization of the biology teachers in the selected Senior High Schools.
2. the financial, human, material and infrastructural resources available for the teaching and learning of biology in the selected Senior High Schools.
3. whether or not the cognitive and process skills specified in the Senior High School biology curriculum are reflected in the teachers‟ instructional activities.
4. the aspects of the biology lessons, which were in agreement with the Senior High School biology curriculum prescriptions.
5. the aspects of profile dimensions (knowledge and comprehension, application of knowledge, practical, and experimental skills) specified in the biology curriculum that are exhibited by the students during practical activities.
6. whether support services and capacity enhancing activities were organised for the biology teachers.

1.5 Research Questions

In this study, the following research questions were answered:

1. What are the educational qualifications and areas of specialization of the biology teachers in the selected Senior High Schools?

2. What resources are available for the teaching and learning of biology in the selected Senior High Schools?

3. Which of the cognitive and process skills specified in the biology curriculum are reflected by the teachers" instructional activities in the Senior High Schools?

4. Which aspects of the biology lessons are in agreement with the Senior High School biology curriculum prescriptions?

5. Which aspects of the profile dimensions specified in the biology curriculum do the students exhibit during biology practical activities?

6. What support services and capacity enhancing activities are organised for the biology teachers in the selected Senior High Schools?

1.6 Significance of the Study

Firstly, this study would illuminate factors, which affect the evaluation of Senior High School biology teachers" implementation of the biology curriculum. It will therefore provide information about what transpires in the implementation of the Senior High Schools biology programme. This study will also provide the MOE/GES, Science Teachers and for that matter Biology Teachers and Heads of Senior High Schools information, which will enable them adopt strategies that might improve teachers" and students" attitudes to biology as well as the learning environment of the sciences.

Secondly, the study will unearth and document practices, which might give some insight into factors contributing to low performances in WASSCE examinations as reported by Chief Examiners.

Thirdly, this study provides useful information on how biology lessons are organised in Ghanaian Senior High Schools, and the role teachers play in the teaching and learning of biology from the teachers‟ perspective. This study will therefore, not only make an important contribution to the study of science through laboratory activities, but will also contribute to improving teaching and learning. Also this study, will contribute to the debate on the role of laboratory based practical activity and its impact on teaching and learning of biology in Senior High Schools in the Ghanaian context.

Finally, this study would have significance for future policy formulation in Ghana on the implementation of biology curriculum at Senior High Schools in Ghana.

1.7 Delimitations

There were a total of 58 Senior High Schools running the General Science programme (and specifically biology) in the Central Region of Ghana at the time of the study. The study confined itself to only 21 schools, which were categorised into grades A, B and C, according to the Ghana Education Services Register of Programmes and Courses for Public and Private Senior High Schools, Technical and Vocational Institutes (2017, edition). Only form two biology students were used in this study as the population of interest, since, they were not preparing for their final examinations, and were therefore, in a position to share their views on the biology curriculum.

1.8 Assumptions

Despite the obvious advantages of integrating quantitative and qualitative methods of data collection, these methods are based on different assumptions. Some assumptions, which informed this study, were;

- biology teachers like all teachers, possess professional knowledge which include content knowledge, general pedagogical knowledge, knowledge of learners, curriculum knowledge, and pedagogical content knowledge acquired through their pre-service programmes, the years of teaching experience and various in-service training programmes.
- the possession of this knowledge allows the teachers to reason and make decisions that will enhance their students understanding of biology as they teach.

1.9 Limitations

There was a restriction imposed on the data, because of the decision to use only 21 of the selected Senior High Schools in itself was a limitation. Although possible, there could be some differences in the attention given to biology practical activities in such schools, the differences would not be so wide as to undermine the validity of the study.

Finally, the focus on the 21 selected schools out of 58 places a limitation on the study. This was due to limited financial resources and time at the researchers" disposal. However, from my experience as an assistant examiner of WAEC and biology teacher in the Senior High School level in Ghana, to a large extent the findings in this study are vivid representations of the situation in many Senior High Schools in the Central Region of Ghana. The idea of using the survey was to understand the issues about the implementation of the biology curriculum and the challenges within the context of the 21 schools. Since the fundamental conditions were not very different, the key issues would still be relevant for the vast majority, if not all the other Senior High Schools".

1.10 Definition of Terms

Some terms used in the study have been defined as follows:

Biology Teacher- This refers to any person who taught biology in the selected Senior High Schools irrespective of their areas of specialization.

Biology Curriculum- This refers to the elective SHS biology syllabus designed by the CRDD in 2010.

Curriculum- Curriculum is the totality of learning experiences provided to students so that they can attain general skills and knowledge at a variety of learning sites. In this study the curriculum is the biology syllabus.

Educational Qualifications- This refers to the professional and academic qualifications of the SHS biology teachers as well as their areas of specialisation.

Evaluation- This is a decision about how significant or valuable something is, based on its good and bad features.

Implementation- This is carrying out a plan, decision or a scheme

Resources- In this study the term refers to the material, human and financial resources in the schools. These include infrastructural facilities.

1.11 Organisation of the Thesis

The thesis has six chapters, which have been logically arranged to provide insights into the issues raised in this section and to provide answers to the research questions. Chapter two of the thesis is devoted to a general review of the relevant literature on issues pertaining to the study, namely teachers" academic and professional qualifications, available resources, types of cognitive and process skills reflected by biology teachers" instructional activities among others. The final part of chapter two looks at the conclusion.

Chapter three discusses the research methodology for the study. It describes the type of study and design and the rationale for the design. The strengths and weaknesses of the design are also discussed. Issues relating to population and sampling, instruments, data collection procedure and data analysis are also discussed in detail.

In chapter four, the results of the study are presented in detailed analysis. The chapter contains extensive use of verbatim quotations from students and teachers to illustrate the perspectives of participants in the research, and is in keeping with the traditions of reporting qualitative studies in evidence (Akwesi, 1994).

Also, in chapter five, the results are discussed according to the themes of the research questions of the study. Implications and conclusions relating to the findings are also discussed. The chapter contains detailed analysis of the results thoroughly explained.

Finally, in chapter six, an overview of the research problem and methodology is provided. A summary of the key findings and their interpretations with reference to the literature are also prescribed. In addition, the issues unearthed for possible future research are presented.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter deals with the review of literature that relates to this study. Under this chapter theoretical framework and models of curriculum evaluation were covered. It continues with literature, which would be reviewed along the importance of the academic and professional qualifications of teachers‟ in the implementation of the biology curriculum, and also the importance of resources for the implementation of teaching and learning of biology in Senior High Schools. Again, the importance of cognitive and process skills in biology teachers‟ instructional activities was discussed. The perspectives of curriculum implementation were looked into. The effects of support services and capacity enhancing activities on Senior High School biology teachers‟ output were also deliberated upon. Knowledge gaps in the literature and the conclusion ended the chapter.

2.1 Theoretical Framework

This study drew its theoretical framework from constructivism, which has two belief systems, radical constructivism and social constructivism. With regards to, the formalization of the theory of radical constructivism, according to Von Glassersfeld (1990) is generally attributed to Jean Piaget (1896-1980). According to Von Glassersfeld (1990), Piaget suggested that through processes of accommodation and assimilation, individuals construct new knowledge from their experiences. Radical constructivists view learning as a process in which the learner actively constructs new ideas or concepts based upon past and current knowledge experiences. In relation to psychology, recognition to the further development of radical constructivism in regard to classrooms and learners can be given John Dewey (1859-1952), Jean Piaget (1896-1980) and Lev Vygotsky (1886-1934). Social constructivism is considered as an extension of the traditional focus on individual learning to addressing collaborative and social dimensions of learning. Social constructivists posit that knowledge is constructed when individuals engage socially in talk and activity about shared problems or tasks (Jones, 1996) and that knowledge is interwoven with culture and society (Ernest, 1992).

What these theories are suggesting is that a learners" mind is not like an empty vessel (tabular rasa) that has to be filled with knowledge but that a learner is an active learner who is capable of constructing the meaning of new knowledge from known and related experiences and also through social interaction with other learners in a group. The implication of these to teaching is that teaching should be learner-centred rather than teacher centred and in a collaborative, co-operative, small-group and large-group discussion environment. According to Vygotsky (1978), learners are capable of performing at higher intellectual levels when asked to work in collaborative situations than when asked to work individually. This study therefore draws its theories from the radical and social constructivists" theories of learning which is also clearly stated and suggested by the biology curriculum.

2.2 Models of Curriculum Evaluation

Curriculum Evaluation, according to Ornstein and Hunkins (1998), is "a process or cluster of processes that people perform in order to gather data that will enable them to decide whether to accept, change, or eliminate something- the curriculum in general or an educational textbook in particular" (p. 320). Worthen and Sanders (1987), on the other hand defined curriculum evaluation as "the formal determination of the quality, effectiveness, or value of a programme, product, project, process, objective, or curriculum" (pp. 22-23). In whichever way one considers the definition of the term curriculum evaluation, its aim is to identify weaknesses and strengths as well as problems encountered in curriculum implementation; to improve the curriculum development process; and to determine the effectiveness of the curriculum (Gay, 1985). Its processes involve delineating, obtaining, and providing useful information for judging decision alternatives. With its underpinning primary decision alternatives were to maintain the curriculum as it is, or to modify the curriculum and/or to eliminate the curriculum (Oliva, 2005).

In evaluating the curriculum to determine its effectiveness and weaknesses, in order to provide information for judging decision alternatives, several models have been propounded to guard the choice of particular aspect of the curriculum to be evaluated. Some of the models are the Stake"s (1967) Countenance Model that focuses on description and judgment; Tyler"s (1949) Goal Attainment Model which focuses on formulation of goals through detailed analysis of feedback from students, society and subject matter; Stufflebeam"s (1983) CIPP Model which evaluates context, input, process, and product of the curriculum; the Scriven"s (1967) Goal Free Model which prescribes the minimum levels to be achieved by a programme. For the purpose of this research, attention would be on the CIPP model. This was because the model identified the areas of interest to the researcher. These were the school environment (context) in which the biology curriculum is being implemented; the resources (inputs) that are available at the environments (Senior High School"s) where the implementation is being carried out; the circumstances under which the evaluation is being done (whether continuous or periodically) and the final outcomes of the implementation as well as the evaluation process.

In addition, this model was considered very appropriate because the main aim for the study was to find out and establish through very authentic means, the success or otherwise of the Senior High School biology curriculum implementation. It also aimed at informing the designers of the curriculum for them to decide on the type of innovation, improvement and change strategies to employ. Stufflebeam identified all these in his CIPP model.

CIPP Evaluation Model

Evaluation is required at all levels of the programme implemented. This is schematically shown in Figures 1 and 2.

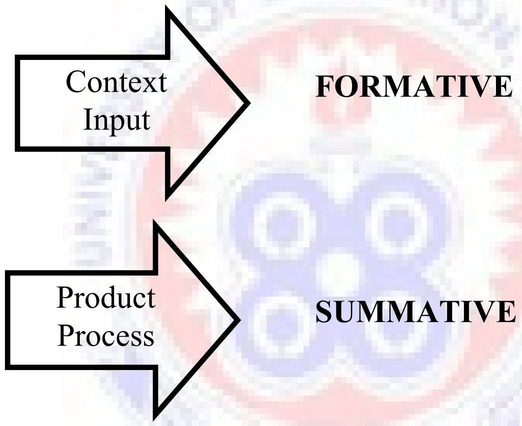

Figure 1: Stufflebeam's model of curriculum programme evaluation

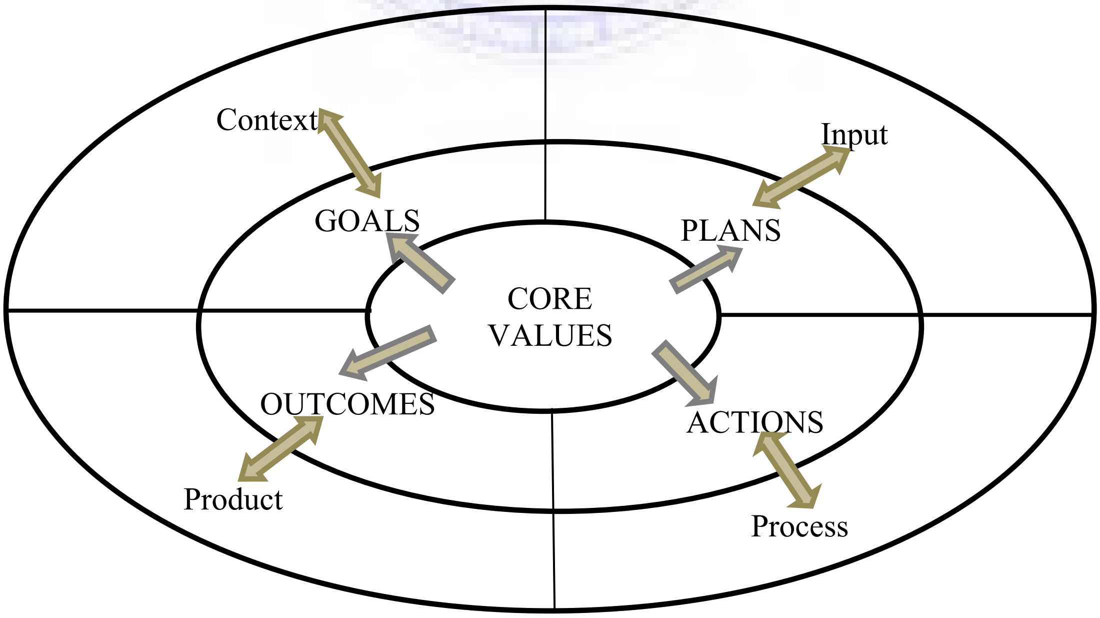

Figure 2: Diagrammatic representation of Stufflebeam's CIPP model

The Stufflebeam"s CIPP Model is a comprehensive approach to curriculum evaluation and provides a means for generating data relating to four stages of program operation namely the context, input, product and process. In Fig. 1, the context and input stages are used in formative assessment whilst the product and process stages are used in the summative stage of the curriculum programme operation. Fig. 2 has three concentric circles; the inner circle deals with core values and the outer two are segmented. The second circle is segmented into the goals, plans, actions and outcomes, which arise from the core values. The third circle is segmented into context, input, process and product, which are in equilibrium with the segmented second circle. The stages of the segments are in equilibrium with each other. The CIPP model is considered as one of the popular decision-focused models. The decision-focused model concerns itself with providing information to aid decision making in respect of curriculum planning, design, and implementation (Adentwi, 2010). The assumption underpinning the approach is the belief that evaluation is worthy only if its results affect future actions (Lewy, 1977). The proponent of this model posits that evaluation information must be properly documented to aid curriculum designers and implementers to effectively make decisions.

Proper implementation of the CIPP Model requires understanding of educational decision-making and procedures for projecting decisions to be serviced. Evaluation would be defined as the process of delineating, obtaining, and providing useful information for judging decision alternatives (Stufflebeam, 1971). The definition of evaluation provides basis underpinning the framework for the CIPP Evaluation Model. Two key dimensions have been combined to form a matrix as the basis for the CIPP Model. The vertical dimension includes the three steps in the evaluation process called delineating, obtaining, and providing, while the horizontal dimension includes four kinds of evaluation, called context, input, process, and product.

In using the CIPP model, to meet educational needs, it must be noted that, no matter how well internal evaluation is performed, no matter how completely the CIPP Evaluation Model is implemented, there is still the need for outside, independent audits and checks on the system. Outsiders should be brought in periodically and invited to ask questions, to make judgments, and in general to provide an outside, external, summative kind of evaluation with respect to a system's goals, designs, procedures, and results (Glatthorn, Boschee, & Whitehead, 2006).

According to the CIPP Model, there are four kinds of decisions, called planning, structuring, implementing, and recycling, which respectively are served by context, input, process, and product evaluation.

Context Evaluation

Context evaluation provides information about the strengths and weaknesses of a total system to assist in planning improvement-oriented objectives at each level of the system. Again, context evaluation deals with determining the actual condition and isolating "unmet needs" as well as the opportunities that could be utilized. Thus, Context evaluation provides a rationale for determining educational objectives by defining the relevant environment, describing desired and actual conditions of the environment, identifying unmet needs, and diagnosing problems that prevent needs from being met (Webster & Mendro, 1998). To fulfil this purpose, a systematic context evaluation program must delineate, obtain, and provide appropriate information in time to make planning decisions.

Delineation of context evaluation should include on-file records of the operational specifications and goals of the major programmes of the institution, and projections of the "planning" decisions that must be made with respect to each of these programs during both the immediate and the longer-range future. Another delineating activity is systematic contact between the context evaluators and decision makers for the purpose of identifying emergent problems that might require decisions to change objectives or priorities in the institution.

To aid planning decisions, information must be obtained which identifies unmet needs, unused opportunities, and problems. An on-going program of data collection is needed with respect to the achievement of institutional objectives at the overall institution level and at the level of each of the programs in the institution.

It cannot be overemphasized that in collecting context evaluation information, the perceptions of the institutional constituencies should be surveyed and analysed. Planners in the institution must be aware of how their products, whether from research, development, instruction, or leadership activities, are perceived and employed outside the institution.

Context evaluation reports should be provided annually to all decision bodies in the institution being served. Such reporting activities should include both the dissemination of printed material and face-to-face oral presentations to particular decision groups to assist in interpreting the information relative to particular programs. Such decision groups could include boards of education, administrative cabinets, groups of principals or individual school principals, project directors, supervisors, teachers, students, and parent groups. Context evaluators should work closely with the institutional programmes so that the information provided by such profiles could be used to improve institutional programmes (Stufflebeam, 1971).

Input Evaluation

Input evaluation provides information about the strengths and weaknesses, as well as the merits and demerits of alternative strategies, which might be chosen and structured for the achievement of given objectives. In all, the Input evaluation assesses relevant capabilities of responsible agencies and identifies strategies for achieving the objectives determined through context evaluation as well as suggesting designs for implementing selected strategies (Webster & Mendro, 1998). To fulfil these purposes, an input evaluation unit must possess personnel, resources, and procedures to be used in conducting ad hoc input evaluation studies after a decision, which specifies new objectives. Then it is necessary to inquire how the chosen objectives can be efficiently and effectively achieved (Stufflebeam, 1971).

The delineating step for an input evaluation involves the translation of given objectives into criteria and alternative procedural strategies. The input evaluation team will assess alternative strategies, but will not formulate them. A complete record would be developed concerning the outputs of the delineating steps.

Obtaining aspects of the input evaluation involves gathering and analysis of criterion information for each of the alternative strategies, which was specified during the delineating step of input evaluation. To obtain such information, reports should be developed for each of the identified strategies, which reflect their strengths and weaknesses relative to the given objectives. Also, they should reference relevant research and development literature pertaining to past use of the strategies.

The evaluation unit should report input evaluation information to the decision makers in the form of individual reports for each of the competing strategies. Further, there should be an analysis of the strengths and ease of use of each strategy relative to achievement of the given objectives. If a strategy aids achievement of one objective, but hinders another, the relative effect of the strategy on the overall program should be analysed (Stufflebeam, 1971).

Process Evaluation

Process evaluation provides information about the strengths and weaknesses of a chosen strategy under conditions of actual implementation, so that either the strategy or its implementation might be strengthened or neglected. Process evaluation provides periodic feedback to individuals concerned with the implementation of plans and procedures to predict or detect faults in procedural design or implementation so that interim adjustments may be made if warranted (Webster & Mendro, 1998). It is at this stage that the evaluator tries to find out about how well the plan is being implemented, what factors are hindering its smooth implementation, what revisions or changes can be made for successful implementation. A secondary purpose of process evaluation is to provide a complete description of the actual program activities. Such description helps to assist programme replication and to assist in determining why programme objectives were, or were not achieved.

The delineating steps for a process evaluation involves identification of potential procedural barriers, structuring decisions that will have to be delayed until the program activities are under way, and the major features of the program design for which descriptive information should be obtained. The focus of the delineating activity is the approved program design (Stufflebeam, 1971).

Information to be obtained in process evaluation involves a daily monitoring of project activities in accordance with variables identified in the delineating step. Process data should be provided regularly to project programme managers. Such information should be provided whenever it is needed for pre-programmed decisions or the removal of procedural barriers. At the end of a project or programme cycle the process evaluator should prepare a report, which describes the actual procedure that occurred, and identifies and assesses discrepancies between actual procedure and the procedure specified in the original program design.

Product Evaluation

Product evaluation provides information for determining whether objectives are being achieved and whether the change procedure, which has been employed to achieve them, should be continued, modified, or terminated. Product evaluation provides interim and final assessment of the effects of educational programs. That is, product evaluation assesses the effects of the strategies selected through input evaluation to meet the needs identified by context evaluation. Such assessment is completed in the light of process evaluation data (Webster & Mendro, 1998). In all, the purposes of product evaluation are to relate outcomes to objectives and to assess the overall worth of a procedure in terms of its effects.

Variables for product assessment should be delineated in terms of the objectives, which have been selected, and in terms of the overall problems that a program has been designed to solve. The product assessment person and the programme personnel should define criterion variables, which relate directly to objectives.

Product information should be obtained by taking both interim and final measures of product criterion variables. In determining the extent to which objectives are achieved, one should consider the effect of the product on the overall needs or opportunities, which motivate the development of the objectives. Major approaches to product evaluation use true experimental design, quasi-experimental design, and comparison of products achieved with specified standards.

Product evaluation reports should be developed and communicated both during and after a project or programme cycle. Such reports should provide both descriptive and judgmental information about project achievements. Achievements should be analysed in terms of the extent to which the intended design was carried out. If satisfactory products are not being achieved, it will be important to consider process information, which would indicate whether or not the designed procedure had been implemented as intended (Stufflebeam, 1971).

According to Scriven (1967), the major goal of the evaluative model is to make credible judgments relative to the merit and worth of educational programmes. Within a discussion of CIPP model of accomplishing this goal, the concepts of formative and summative evaluation would be introduced.

The formative evaluation attempts to provide feedback to programme personnel with the goal of upgrading or improving an educational programme while it is in the developmental stages (Stenhouse, 1975). Using the CIPP, interim product and process data provide formative evaluation information to programme personnel. The focus of summative evaluation is upon the determination of the ultimate worth of a programme or project. This type of evaluation is often implemented at that stage in a programme's life where it has reached some stability. Summative data feed recycling decisions: that is, as a result of summative evaluation information, a program may be terminated, restructured, continued, or expanded. The CIPP, final product evaluation information, interpreted in consideration of context, input, and process data, is used to draw summative conclusions about the merit and worth of an educational program and feed recycling decisions (Webster & Mendro, 1998).

In using the CIPP models, Stufflebeam (2003) argued that evaluators should take into account a set of pertinent societal, institutional, program, and professional/

technical values when assessing programs or other entities. Again, he argued that evaluators and their clients should regularly employ values clarification as the foundation for planning and operationalizing evaluations and as a template for identifying and judging unexpected transactions and results.

Evaluators using the CIPP Model are expected to search out all relevant stakeholder groups and engage at least their representatives in communication and consensus-building processes to help affirm foundational values; define evaluation questions; clarify evaluative criteria; contribute needed information; and assess evaluation reports (Alkin, Daillak & White (1979); Stake (1983); Guba & Lincoln (1989); House & Howe (2000); and Patton (2000).

Stufflebeam (2003), believed the CIPP Model is strongly oriented to involving and serving an enterprise"s stakeholders. While evaluators must control the evaluation process to assure its integrity, CIPP evaluations accord program beneficiaries and other stakeholders more than a passive recipient"s role. Evaluators are charged to keep stakeholders informed and provide them appropriate opportunities to contribute (p.11).

The CIPP Model advises evaluators to use contracted evaluations to encourage and assist evaluation clients to learn evaluation concepts and methods and install or strengthen institutional capacity to conduct and use evaluations (Guba & Stufflebeam, 1970; Stufflebeam, 2003; Stufflebeam & Webster, 1980). While external contracted evaluations are often warranted, they are insufficient to fulfil all of an organization"s on-going requirements for evaluation, informing decision making, maintaining accountability, and fostering institutional learning. Institutions need the capacity to conduct many of their own evaluations and external evaluators should help develop such capacity.

Evaluation in every programme is introduced first, however, in the rare case when the evaluator is called in before the programme begins, potentially the evaluators would conduct all four kinds of evaluation to help guide the programme through focusing, planning, implementation, and success at the end. In the more typical, but often unfortunate case where the evaluator is called in only after the programme has been completed, one might also sum up the programme"s value by looking at context, input, process, and product. Sometimes one is engaged to evaluate somewhere in the programme"s middle. Then one might, at least for the time being, hold context and input evaluation in abeyance and concentrate on process and product evaluation (Stufflebeam, 2003).

In determination of which types of evaluation to apply, the evaluator needs to identify and address the client"s purpose for the evaluation. Whilst a summative evaluation will almost always require all four types of evaluation in order to fully describe the program and appropriately judge its quality, a formative evaluation assignment sometimes would take up only the type(s) of evaluation needed to guide certain programme decisions or answer pointed accountability questions (House & Howe, 2000; Stufflebeam, 2003).

In conclusion, the CIPP Evaluation Model promises a sound evaluative system, both for on-going normal efforts of a system and for change efforts in that system. In both the formative and summative sense it provides information proactively to decision making so that decision makers can be more rational in their decisions, especially in the implementation of reforms in Senior High School biology curriculum.

2.3 The Importance of the Academic and Professional Qualifications of Teachers in Implementation of the Senior High School Biology Curriculum

Teaching is the main way of promoting learning and achievement among students but teaching and learning are what affect knowledge, skills, attitudes, and the capacity of young people to contribute to contemporary societies (Mangal, 2007). The preparation of quality biology teachers must include a solid foundation in biology content. Prescribed courses of study should provide breadth of the basic concepts and principles on which the discipline of biology is built, but must also concentrate on the depth of knowledge available in the subject-matter field. For many years, the academic (subject-matter) component of teacher-education programmes has come under scrutiny; however, recent outcries for improving the quality of teaching and the teaching profession raised new concerns over this issue. These reports call for teachers to demonstrate competence in academic subjects and for institutions of higher learning to "make the education of teachers more intellectually solid" (Holmes Group, 1986).

It has been stated by Cadenhead that teaching, as an intellectual activity should include knowledge, linking content and methodology, and sentences (Cadenhead, 1985). This statement suggests that a quality teacher-education programme in biology should include courses in biology content, scientific methods, general education, and liberal studies. There is no consensus on the proportion of the curriculum or the number of credit hours that should account for each of these four areas. Consequently, there are wide variations in courses required in different curricula. A primary reason for the inconsistencies is the fact that the teacher-education curricula are usually developed around unique certification requirements. Since most countries" requirements for certification lean heavily toward the professional-education component, rather than the subject-matter component, the result is that teacher-education programs tend to be long on professional education, including pedagogy, and short on subject-matter content. This condition has prompted critics of the teaching profession and those involved in the current reform movement to recommend that prospective teachers earn a bachelor"s degree in their subject-matter area before being allowed to enter a professional teacher-education program (Holmes Group, 1986; Carnegie Forum on Education and the Economy, 1986).

There are many challenges faced in the teaching and learning of science subjects in schools (Ackon, 2014). Kola (2013), stated that science teachers are important in the teaching and learning of science and there is no development of science education in any country without considering teachers" contribution. There is a shortage of qualified science teachers in some African countries and in some instances teachers available to teach science may not be qualified to teach the subject (Muwanga-Zake, 2001). If teachers have problems in understanding some of the topics in the subjects that they teach, it raises concerns around their content knowledge (Ramnarain & Fortus 2013). Kola (2013), as well as Ogunniyi and Rollnick (2015), noted the problem of the existence of unqualified science teachers in schools in Africa and how this negatively affects quality science teaching and learning.

It is important that a teacher thoroughly understands a subject in order to teach it effectively. This idea is aptly expressed by Murray (1986), who stated that „the teacher's role is to find and present the most powerful and a generative idea of a discipline which implies that a teacher comprehends the structure of the discipline, its key points and their origins, and the criteria by which one distinguishes the important from the trivial‟. This kind of understanding, sighted in traditional programmes, is of fundamental importance to the teacher-and must have a central place in the teacher's education. He further stated, "the traditional major often does not confer a level of understanding that empowers the teacher (or even the typical college graduate) to understand" (Kumabia, 2014).

Teachers and Curriculum Implementation

It has long been recognized that teachers have a major role in determining and implementing the curriculum. They interpret and give life to the curriculum specifications of governments and ministries, and translate curriculum intentions into classroom practices (Norris, 1998). As Scott (1994) mentions, they not only control the rate but also the degree of change of any curriculum.

According to Kimpston (1985), studies focusing on teachers‟ beliefs about their roles in the curriculum implementation process were the most efficient way to answer the question of what does or does not get implemented in the curriculum. The most important conditions for developing better-designed curriculum materials are provided by analysing teacher roles (van den-Akker, 1988).

Dreyfus and Dreyfus (1985), defined the successful implementation of a curriculum as its spirit being conveyed to the learners by the teachers. Accordingly, what a given teacher believes, knows and does determine the form of education given to a student. If enough were known about the curriculum implementation process and how teachers influence this process, research findings and developments would be more likely to be actually used by practitioners (Connely & Ben-Peretz, 1980, cited in Cronin-Jones, 1991).

On the basis of Heron‟s (1971), conclusion and the results of earlier studies, Mitchener and Anderson (1989), pointed to the importance of the teachers‟ role and stated that they determined the success or failure of a new curriculum. Similarly, Crocker and Banfield (1986), underlined the necessity of a fuller understanding of teacher thoughts, judgments, and decisions relative to curriculum if further progress was to be made in curriculum characteristics and instructional practices. The views of teachers on a range of factors within the school and classroom setting were likely to be important determinants of curriculum translation. Cronin-Jones (1991), also pointed out that teacher‟ perceptions and beliefs play a critical role in the curriculum implementation process. The incompatibility of the objectives and activities in the programmes with teacher views of curriculum characteristics and instructional practices are identified by Crocker and Banfield (1986), as one of the major reasons of failure in many curriculum projects in the 1960‟s.

In a case study of curriculum implementation processes in a fifth grade science class, Smith and Anderson (1984), found a marked difference between intended and implemented curricula due to the different views of teachers and curriculum developers about the concept of learning and the nature of science (Connely & Ben-Peretz, 1980, cited in Cronin-Jones, 1991). The results of Cronin-Jones‟ (1991), study also showed teachers significantly altering curricula to make them more congruent with their own teaching contexts and belief systems. In the light of studies carried out by Smith and Anderson (1984), Clark and Elmore (1981), which reported teachers adapting curricula to fit their knowledge, priorities and unique classroom settings, Cronin-Jones (1991), indicated that teachers do not implement curricula in their classrooms in the same way that these curricula are designed to be implemented; the implementation is often quite different from that intended in the curricula. In her case study, she stated teachers‟ beliefs as the main reason of this difference. She puts teacher beliefs into four categories covering the ways students learn, teacher roles in the classroom, the ability levels of students in a particular age group, and the relative importance of content topics. She supported her findings with Olson"s (1981), study in which the intended curriculum advocated a discovery approach whereas common practice of the teachers involved a lecture and some question-answer activity. This difference results from how teachers deal with proposed changes and how they construe their role in the classroom.

Cronin-Jones (1991), gave a second reason of the difference between intended and implemented curricula, teacher attitudes toward curriculum packages. She underlined Connelly and Ben-Peretz"s (1980), claim that teachers needed to believe in an intended curriculum to properly implement it. She supported her ideas with the findings of Schmidt"s (1983), study in which teachers" allocations of time to various subject matters were reported to depend on the teachers" attitudes toward the subject matter and the degree of enjoyment they experienced in teaching it. She stated that teacher beliefs about the ability levels of students in a given age group and beliefs about which student outcomes were most important and exerted a powerful and a potentially negative influence on the curriculum implementation process.

In an earlier study Duschl and Wright (1989), reported a similar finding, the focused observations in their study revealed a significant difference in teachers" objectives between high level and low-level classes. According to students" ability, teachers" considerations for advancing development and for understanding science content differ. In high-level classes, teachers display behaviours and voice opinions indicating the primary goal of instruction as students acquiring a discipline"s prepositional knowledge or simply its content. Similarly, Smerdon and Burkam (1999), reported that many teachers believe in didactic instruction, drill and practice, to be more effective for students with lower intellectual abilities. They are less likely to use innovative instructional techniques when they believe their students need training in basic skills so that their instruction is often characterized by rote memorization, drill and practice. In contrast, teachers of upper-level courses emphasise higher-order thinking and present more-interesting materials (Eminah, 2007).

In a research programme into the academic work of science classrooms, Gallagher and Tobin (1987), also reported teachers‟ knowledge of science and pedagogy as well as beliefs about teaching and learning as factors, which influenced the implemented curriculum. In addition, they identified teacher expectancies as one of the other factors that influence the implemented curriculum. Their results illustrate how teachers tend to involve target students and males in whole class interactions to a greater extent than non-target students and females. Teacher expectations also appear to influence the science curriculum for high and low ability classes in their study. In another study, Tobin (1987) again, reported teacher expectations as exerting a powerful force on the implemented curriculum. He stressed that teacher beliefs about how students learn and what they ought to learn have the greatest impact following the potent force of teachers‟ knowledge on the implemented curriculum. Hawthorne (1992), also emphasized that the curriculum enacted in each classroom results largely from the individual teacher‟s preferences, professional understandings, and perceptions of student needs and interests.

Although their beliefs, perceptions, attitudes, knowledge and expectations are reported to have the greatest impact on the implemented curriculum, teachers also complain about several constraints that hamper them in carrying out the desirable curriculum tasks (Effah, 2014). In Kimpston‟s (1985) study, lack of time was identified as the overriding constraint, followed by a teacher‟s own lack of capability and the absence of an established process in the district for carrying out the task. Tobin (1987), indicated that, relatively a large amount of content teachers feels obliged to cover as another constraint that prevents teachers from achieving the curricula objectives in the intended manner. He reported that most of the teachers participating in his study found class time to be insufficient to provide students with opportunities to discuss their understanding of a topic and apply their knowledge in a range of contexts. However, he questioned how teachers would change their strategies if the amount of content were substantially reduced or the amount of instructional time increased. Tobin identified classroom management, examinations and textbooks as other factors that constrain teachers when they try to implement the curriculum in the desired ways.

Lederman (1999), pointed to classroom management as a perennial concern of novice teachers that have not developed a wide variety of instructional routines and schemes that allow them to feel comfortable with the instruction. Mitchener and Anderson (1989), highlighted the teachers‟ concerns regarding losing class control as a cause of passive resistance to role changes; this was a characteristic of current curricular reforms. For instance, teachers feel uncomfortable with the facilitator role compared to their traditional lecturer-expert role (Ackon, 2014).

Scott‟s (1994) study, also pointed to the limiting factors identified by teachers to implement the curriculum in the intended ways. These factors are time constraints, lack of resources and facilities, own limited knowledge, need to cover a variety of contexts, pressure of exams, lack of interest by students, too much in syllabus and different backgrounds of students.

Researchers in the field also gave some characteristics of teachers that may possibly influence what they do in the classroom; how they translate curriculum intentions into classroom practices. For instance, Evans (1986), indicated age, sex, years of experience and educational background of teachers were all potentially important determinants of the implementation process. The findings of his study showed that, as the degree of implementation increases, attitude scale and more cognitive measures and years of experience decrease. He reported that high implementers were more likely to display a favourable attitude toward the materials and programme yet they tend to be less experienced and were likely to score lower on achievement or more on cognitive measures. The low implementers who were slightly more experienced tend to have higher scores on achievement measures and displayed a less favourable attitude towards the programme.

Similarly, years of teaching experience was reported by Lederman (1999), to cause clear differences between the classroom practices of teachers. The results of his study indicated that experienced teachers (14 and 15 years of experience) exhibited classroom practices consistent with their professed views about the nature of science: they included many inquiry oriented activities (i.e., demonstration and laboratory practices) that required students to collect data and infer explanations for the data that had been collected. Novice teachers, with less than 5 years of experience, struggled to develop an overall organizational plan for their courses and were a bit frustrated by the discrepancy between what they wanted to accomplish versus what they were capable of accomplishing with their students (Effah, 2014).

Effah"s (2014) findings, also showed that years of teaching experience affected teachers" views of the value of the curriculum. Therefore, they demonstrate different meanings of fidelity of implementation in their everyday classroom situations. For instance, Cho (2001), reported that the novice teacher in the study faithfully used the new curriculum materials based primarily upon the intent of the curriculum developer. What worked best for student learning in her classroom was guaranteeing the right things covered at right times and in an organized manner because the teacher herself felt the need to learn new skills and build on her knowledge for teaching. In contrast, the experienced teacher considered the new curriculum materials to be teaching tools and adaptively used the ideas of the curriculum developer. The critical decisions she made were directly related to her interpretation of students" needs, as she perceived them.

The history of implementation research showed that planned change attempts rarely succeeded as intended (Fullan & Steigelbauer, 1991). De Jong (2000), reported high failure rates with teachers who must learn new skills while maintaining their daily work schedules and responsibilities. Yee and Kirst (1994), indicated that teachers used the new materials without a thorough understanding of the required changes most of the time. They also mention the developers" failure to account for the structural constraints to changing teachers" practices for example, that many of the materials require longer class periods, that they require changes in classrooms and in school wide organization, significant amounts of time to prepare materials and the construction of new laboratory facilities. For this reason, Shkedi (1998), asked curriculum developers to rethink the ways in which teachers encounter the curriculum. He underlined the need to devise means that suits the teachers" narrative world of knowledge and thought, and one that is communicative to them and speaks in their professional language. He indicates the need for a curriculum guide to be developed that uses a language that represents the teachers" world and the complexity of everyday classroom life. From another perspective, van den Akker (1988), called for the desirability of curriculum materials to contain a large amount of "procedural specification" for a teacher" s initial use that is very accurate as to how its advice is focused on essential but apparently vulnerable elements of the curriculum. With the help of such specific materials teachers are stimulated to take a task orientation and to perform a concrete role in the introduction of new curricula, using their experiences and being supported with practical advice, to produce successful lessons. However, at the end of a review of literature Coles, McRadu, Allison and Gray (1985), reported centrally developed curriculum guides to have limited influence in determining the programs and activities of teachers. Similarly, findings of their own study confirm limited usage of curriculum guides by teachers except for long range planning.

In order to increase the usage of curriculum guides by teachers in every part of their instructional planning, Shkedi (1998), stressed the need for the guides to have a different character, one that corresponds to the language, thought, and knowledge of teachers. The curriculum guide has to transmit its message using the appropriate medium, and it is not necessarily via the written word and should be designed to reflect both the teachers‟ and developers‟ intentions.

Olson (1982), Aikenhead (1984), and Mitchener and Anderson (1989), stated that curriculum developers working cooperatively with classroom teachers gain a better understanding of the operant issues when implementing theories into practice. Writers in the curriculum field who have focused their concern on theoretical perspectives relating to curriculum implementation also tend to agree that teachers who believe they are involved and effective in curriculum development show greater congruence between intended and actual use of a curriculum (Kimpston, 1985). Therefore, rather than looking at teachers as passive transmitters of information and new curriculum as a thing ready to elicit a certain type of adoption behaviour, attention should be given to the intentions of and the practical problems faced by individual teachers in the implementation process.

Lastly, Mitchener and Anderson (1989), noted that their colleagues‟ and students‟ impressions and behaviours heavily influenced a teacher‟s daily practice. They reported that teachers are attempting to adjust to new situations and new roles that come with curriculum changes. However, many studies investigating implementation process highlight the teachers‟ usual resistance to curricular and instructional innovations (Eminah, 2007).

In concluding the discussion of the first major issue, I strongly suggest that each institution that prepares biology teachers consider establishing a biology teacher-education council consisting of faculty from colleges of education, science education, and the biological sciences departments at the universities. The council would be responsible for periodically reviewing the biology teacher-education curriculum to ensure a solid foundation in the content of the Senior High School biology curriculum content.

2.4 The Importance of Resources for the Implementation of the Biology Curriculum in Senior High Schools

Resources according to this study focussed on the financial, human, material and infrastructural facilities. Sources of financial resources were through the schools‟ internally generated funds (IGF), PTA, Old Students Associations (Alumni), and Government through the Regional or District Offices. The human resources included the biology teachers‟ trained and untrained, laboratory technicians, laboratory assistants and laboratory attendants. The material resources also included equipment, apparatus, glassware, herbarium, chemicals, preserved specimen, models (human parts, organisms, skeletal system etc.) and biological charts. Also the material resources play an integral role in the teaching and learning of science as they serve to stimulate thinking, make learning enjoyable, interesting, exciting and concrete. The infrastructural facilities include biology laboratory, preparation rooms, storerooms and ancillary rooms.

Achimagu (2006), classified resource materials into classroom/laboratories equipment/chemicals and textual/audiovisual materials. Resources or facilities according to Udo (2006), refers to facilities that can be used to enhance or improve educational programmes and promote teaching and learning. Science laboratory resources/facilities can be human or material (Kankam, 2013). The human resources have to do with personnel such as lecturers/teachers, laboratory technologist/ assistants and students. The science laboratory material resources are those materials available to the science teacher for teaching and learning. They include textbooks, computers, thermometers, fire extinguishers, first aid kits, oven, incubators, chalkboards, model/mock-ups, television, radio and other electronic devices (Kankam, 2013).

Although some facilities may be available and adequate they may not be put to use by teachers. Udo (2006), is of the view that audio visual aids such as computers and projectors are not utilized in schools due to lack of knowledge on the proper use of such resources for teaching. Onyeji (2004), had earlier reported that none of these new media (electronics) is available, accessible or used in communicating Science, Technology and Mathematics (STM) in secondary schools. Physical laboratory facilities are the fundamental factors in better learning and achievements of the students. All facilities should be provided to the schools for the students" better, concrete, and real experiences. Leeper, Dales and Skipper (1968), stated that the child learns through concrete rather than abstract experiences as there are learners who use different cognitive skills for learning, such as seeing, hearing feeling and touching skills.

Science is doing and involves regular hands – on practical work for learners to develop scientific literacy to face global challenges. The teaching of biology should be student-centered and activity-oriented whilst the teacher acts as a facilitator (Asare, 2010). Biology being a natural science can be studied both indoor and outdoor as most biological specimen are plants and animals, which abound in the environment. However, some laboratory facilities may not be found outside the laboratories such as reagents, equipment and charts, just to mention but a few. Hence, there is the need to have a well-stocked laboratory with available and adequate facilities. For science teachers to play their roles in teaching science, laboratory facilities should be available and used appropriately to improve the performance of students. Students‟ poor performance in biology especially at West African Senior Secondary Certificate Examinations (WASSCE) level has become a source of concern to all stakeholders in education in Ghana (Owiredu, 2012). One of the major reasons for this anomaly is the lack of or inappropriate application of laboratory facilities in the teaching of science by Senior High School science teachers (Asiyai, 2012). Biology, as a key science subject, is offered by most Senior High School students (Adodo & Oyeniyi, 2013). It is a core subject required for medical sciences, biotechnology, pharmacy, microbiology, agriculture, oceanography to mention but a few.

One would be tempted to assume that the high enrolment in biology and the fact that it deals with familiar objects like living things in general and the human body in particular, would imply high performance. From observations, performance in sciences is poor when compared with other subjects (Adodo & Oyeniyi, 2013). A review of student‟s performance in biology in the West African Senior Secondary Certificate Examination (WASSCE) from 2000 to 2015 in Ghana revealed fluctuations and downward trends in students‟ performance. This has attracted a lot of concern among science educators. In order to achieve the objectives and the aspiration of the government and to improve students‟ performance in biology, efforts should be directed towards improving teaching and learning of the subject (Ahorlu, 2013).

Researchers such as Oladare, Abiodun, and Bajulaiye (2006); Lavrenz (2006); Akpan (2006), Inyang (2006), Adesoji (2008); and Ihuarulam (2008) stated that there were inadequate resources for teaching and learning of science subjects in public secondary schools in Nigeria. They further stated that where there are little resources at all, they are not in good condition, while the few ones that are in good condition are not enough to go round and also the few available material are dysfunctional. This can therefore be said to be same in the Ghanaian context (Ackon, 2014).

Empirical studies conducted in relation to resource utilization in education have revealed that essential facilities were not always available in the schools. This inadequacy of teaching resources has been of serious concern to educators (Kennedy, 2009). Lyons (2012), stated that learning is a complex activity that involves interplay of students‟ motivation, physical facilities, teaching resources, skills of teaching and curriculum demands. The process of managing and organizing resources is called resource utilization. The utilization of resources (laboratory facilities) in education brings about fruitful learning outcomes since resources stimulate students learning as well as motivating them (Asare, 2010).

Methods employed by teachers to teach mathematics and science subjects in primary and secondary schools are to a very large extent influenced by the kind of resources and facilities available in the school. The teaching methods, in turn, influence the level and quality of participation and performance in SMT by students, particularly girls. In general, where resources and facilities - teachers, textbooks, laboratories, chemicals, tools and equipment, teaching aids, stores, offices etc. are inadequate, the teaching approach tends to be teacher-centered. This type of approach is heavily dominated by the teacher as he or she lectures on the subject, gives notes and demonstrates the practical aspects of the lesson. The students remain passive participants, expected to listen and observe only. The teacher, therefore, is the sole source of knowledge for the students. This can be risky in the event that the teacher is inadequately informed on the subject or is not adequately trained in the art of communication. A teaching approach that centers on the teacher is bad for science teaching and learning and soon kills the interest of students in the subject (Effah, 2014).

But where facilities and resources were available, a qualified and motivated science teacher will deploy methods that centred on the learner. Such an approach emphasizes practical activities and has the students experimenting, solving problems, discussing with each other and involved in practical hands-on-activities. This approach stimulates curiosity, imagination and critical thinking. It keeps the lessons exciting and captivating to the young people, particularly girls, knowing therefore the critical role played by adequate resources and facilities in effective teaching and learning of science (Asare, 2010).

Although the school may have other peripheral objectives, the major goal of the school is to work toward attainment of academic excellence by students (Adeyemo, 2001) mainly because virtually everyone concerned with education places premium on academic achievement. Excellent academic achievement of children is often the expectation of parents (Babatunde & Olanrewaju, 2014). Academic failure is not only frustrating to students and their parents; its effects are equally grave on the society in terms of dearth of manpower in all spheres of the economy and politics (Babatunde & Olanrewaju, 2014).

The school environment has been described as an organization, where resources are produced, managed and organized in a way that enables students to acquire desirable learning competencies. Denyer (1998), in his study on science games in National Curriculum in the United Kingdom reported that games when used as a resource enable less able children to stay on task and remain motivated for longer period.

There are varieties of resources, which the science teacher can readily use to enrich learning. These resources are wind vane, rain gauge, metre rule, models, charts, preserved specimens of plants and animals, culturing equipment, herbarium, terrarium, vivarium and microscope (Olagunju, 2000). The resources should be provided in quality and quantity in STM classroom for effective teaching-learning process (Umeoduagu, 2000). Nwoji (1999), in an empirical study, revealed that essential facilities, including such equipment as radio, television, computers, chemicals, specimens, video tape, stove, burners, models and charts are not available in schools. This inadequacy of teaching material resources, laboratory equipment/ reagents/chemical, and laboratory space, has been of serious concern to educators.

The decline in performance in STM may not be unconnected with poor learning environment created by this state of infrastructure facilities (Fabayo, 1998; Farombi, 1998). Mapaderun (2002) and Oni (1995), also emphasized that the availability and adequacy of these facilities promote effective teaching and learning activities in schools while their inadequacy affects the academic performance negatively. Several efforts have been extended by Science Teachers Association of Nigeria (STAN) to train secondary school teachers on improvisation techniques in various science subjects including biology, hence there is need to evaluate how far teachers have been able to improvise instructional materials for effective teaching.

There are many challenges faced in the teaching and learning of science subjects in schools. Kola (2013), states that science teachers are important in the teaching and learning of science and there is no development of science education in any country without considering teachers‟ contribution. There is a shortage of qualified science teachers in some African countries and in some instances teachers available to teach science may not be qualified to teach the subject (Muwanga-Zake, 2001). If teachers have problems in understanding some of the topics in the subjects that they teach, it raises concerns around their content knowledge (Ramnarain & Fortus, 2013). Kola (2013), as well as Ogunniyi and Rollnick (2015), noted the problem of the existence of unqualified science teachers in schools in Africa and how this negatively affects quality science teaching and learning.

The Senior High School biology syllabus from the WAEC emphasise the acquisition of scientific skills (e.g. accurate observation, measurement and recording), laboratory skills as well as scientific attitudes (e.g. Concern for accuracy, objectivity, integrity, initiative etc.). It is therefore expected that students would go through a science curriculum, which include practical work in preparation for the final WAEC science practical examinations. With the provision of science resource centres, it is also expected that students in disadvantaged schools would have the opportunity to undertake practical activities. However, a variety of specific students‟ weaknesses in the practical examinations reported by the Chief Examiners cast serious doubts on Senior High School students‟ involvement in practical activities in the schools. This gives the impression that students are either not taken through practical activities or did not take them seriously (Owiredu, 2012). Some of the persistent weaknesses identified over the years (2000-2015) by the Chief Examiners for the sciences are as follows:

Biology:

i. Technical terms were wrongly spelt and also failure to adhere to the convention of writing scientific names.
ii. Candidates were incapable of critical analysis and interpretation of biological data.
iii. Candidates should be given sufficient tutorials and assignments on concise and accurate answers as well as going through rubrics and comprehension of the subject.
iv. Candidates are not having adequate practical work as shown by the answers provided.
v. Most candidates could not draw diagrams from observation of specimen; thus the standards for drawing were very poor.
vi. Inability to design simple experiments.
vii. Descriptions of graphs drawn were inaccurate and explanation of the data provided for the graphs was poor.
viii. Some candidates presented very poor and inaccurate genetic diagrams.
ix. Difficulty in relating observable features to their functions.

All these instances are happening despite the fact that Science Resource Centres for both host and satellite schools have been established to serve as teaching centres to supplement existing facilities in Senior High Schools, to give ample opportunities for practical work by students, using modern facilities and techniques, including the use of computers (Ampiah, 2004).

Class size is an important factor with respect to academic performance of students. There is consensus among researchers and educational scholars that students" achievement decreases as class size increases (Ackon, 2014; Babatunde & Olanrewaju, 2014). Similarly, overcrowding in a classroom made it complicated for teachers to manage each individual"s attention and also make use of various teaching and assessment methods (Morrow, 2007). Where a teacher is limited by space and is unable to provide individual attention and supervision, students who are unattended to tend to disturb the class and distract the attention of other students during lessons (Squires, 2002). As Jolivette, Scott, and Nelson (2000) noted, the level of distractibility within the classroom, the density of class size, and social interaction with specific students or staff are potential barriers to high performance.

According to Amos and Boohan (2002), audio-visual materials assisted in bringing the real world to learners and these can be done by utilising the use of sound and video. Nayar and Pushpam (2000), observed that through the integration of appropriate media in the curriculum, learners" achievement received significantly higher learning outcomes. Using appropriate audio-visual materials in science teaching and learning assist even slow learners to understand scientific concepts (Nayar & Pushpam, 2000). McSharry and Jones (2000), saw the enactment of scientific processes as vital in ensuring active and experiential learning. This was in line with Vygotsky"s social constructivist theory. In all instances, effective teaching and learning of science through the utilisation of appropriate approaches and techniques was only possible where resources are available (Asare, 2010).

The importance of laboratory apparatus, in teaching and learning of science cannot be overemphasised. Learners" involvement in practical activities in the laboratories assists them to better understand scientific processes. The issue of the importance of a laboratory in science teaching, therefore, cannot be overemphasised. In a laboratory and with the relevant material and equipment, learners are provided with the chance to actively learn science, which is by nature investigative (Tobin 1990).

The importance of learners‟ active involvement in science learned is further emphasised by Osborne and Collins (2000), who argued that learners construct meaningful scientific knowledge and investigative processes by being actively involved in science knowledge construction. Similarly, Orji (2006), noted that the availability and proper use of relevant materials such as library materials and science laboratory equipment has a positive influence on learner performance and ultimate attainment.

The aim of this study was to provide a knowledge base for policy-makers and teacher educators in the implementation of the new Senior High School biology curriculum and textbooks, which have been used since the 2004/2005 to 2010/2011 academic years. Knowing students‟ views of the factors affecting their learning and suggestions on how to make biology teaching and learning effective may facilitate the implementation of the new curriculum and help policy-makers and teachers to update it in line with students‟ learning needs. Additionally, teachers can see their weak and strong areas regarding teaching biology (Ahorlu, 2013).

Disparities in Resource Distribution

Ghana‟s efforts at raising the living standards of Ghanaians and ensuring economic growth have, however, left a legacy of extreme disparities in development in terms of the demographic and settlement patterns, distribution of social infrastructure and levels of economic activity. This has resulted in substantial differences between urban and rural settings with regard to the distribution and quality of educational facilities and manpower, just as levels of utilization of resources and access to tertiary education also differ slightly between urban and rural schools (Siaw, 2009). Increased rural–urban migration has also brought millions of people living in rural areas to the urban centres. Variations in teacher–student ratios, human resource capacity, provision of educational infrastructure, and other facilities have also led to rural, urban, and regional differences in educational opportunities in different parts of Ghana (Atuahene & Owusu-Ansah, 2013; Banson, 2010; Osei-Mensah, 2012; Owusu-Afriyie, 2009; The President"s Committee on Review of Education Reforms in Ghana, 2002; Siaw, 2009).

Rural schools in Ghana lack good infrastructure and facilities, they have low enrolment, less qualified teachers, and fewer textbooks, and other teaching and learning materials, whereas urban schools are generally overstaffed with qualified teachers, are overenrolled, better funded, and monitored, have better infrastructure and adequate resources to work with (Anamuah-Mensah, 2002; The President"s Committee on Review of Education Reforms in Ghana, 2002; Siaw, 2009). The achievement gap between urban and rural schools is a pressing problem today because past approaches at closing this gap have been largely urban biased in character (Siaw, 2009).

The global change in science curriculum arising from knowledge explosion and new wave in science and technological development demands for qualitative science teaching. According to Oludipe and Lasis (2006), the change calls for the provision and utilization of resources, which tend to enhance the effective teaching and learning of science. Resource materials are all the materials, objects and aids that can be used in helping children to learn.

Similarly, Gbamanja (2003), opined that the use of materials in teaching could make learning more practical, applicable and meaningful. Citing Dale, Finn & Hoban, (1949), they went further to stress the fact that resource materials are things that;

- supply a concrete basis for conceptual thinking and reduce meaningless word responses of pupils.
- make learning more permanent.
- have a high degree of interest for the learner.
- offer a reality of experience, which stimulates self-activity on the part of pupils.
- develop a continuity of thought.
- contribute to growth of meaning and, hence to vocabulary development.
- provide experiences not easily obtained through other materials and contribute to the efficiency, depth and variety of learning.

Material resources remain useless if there are no qualified teachers to put them into use. Thus, the science teacher is an indispensable human resource that has a vital role to play in the utilization of all other resources (Kankam, 2013). Aggarwal (2006), commenting on the vital role of the teacher puts it succinctly. Premises and equipment are needed in the education enterprise and persons are vital to them and a teacher is the supreme factor. There is no exaggeration that a spacious building, costly equipment, and a sound syllabus will serve some useful purpose only when there are teachers who are fully alive to the nobility of the profession and its accompanying responsibilities…(p:396).

In the same vein, Buseri (2010), contended that to meet up with the rapid scientific progress in technology required the presence of well-trained, efficient, knowledgeable and skilful teachers who were versatile in the discharge of their duties and responsibilities. The availability of adequate and qualified science teachers cannot be compromised for the success of any science programme. It has been commented that, however well-conceived a programme is, however valid the theory that underlies it, and whatever the objectives of the plan would be determined by the nature, quality, attitudes, motivation and convictions of the classroom teacher (Sazi, 2013).

Shortage of qualified science teachers and lack of equipment amongst others have been identified as constraints against the advancement of science education in Ghana. For Ghana to meet up with the challenges of human capacity development for sustainable development there must be both material and human resources (Ahorlu, 2013).

Challenges Faced in the Utilization of Resources

There are many challenges facing utilization of resources; the major one, according to Todzro (2010) and Kankam (2013), was that the teacher must know all available teaching aids, select appropriate ones and guide students in their use so as to obtain correct information. Patel and Mukwa (1993), concurred and also added that timely and proper presentation was very crucial in attaining a learning objective, the availability of proper selection of resources notwithstanding. The high cost of teaching and learning resources, according to Orwa and Underwood (1986), was an impediment to learning, especially in the district schools that frequently experienced shortage of funds.

Students face problems while observing biological specimen especially where they are required to compare them (Kankam, 2013). They often looked at differences than similarity (Hertem & Jelly, 1990). This can result in wrong hypotheses or conclusions on observed items in a classroom situation. High costs of instructional resources is an impediment to learning especially in rural schools with low financial ability prompting Orwa and Underwood (1986), to suggest that classroom resources should not involve outlay of expensive scientific equipment. Sometimes low quality resources may make achievement of learning objective difficult (Brown & Wragg, 1993).

In conclusion, human and material resources such as schools‟ laboratory facilities have been observed as a potent factor to quantitative education. The availability of laboratory facilities is essential for effective teaching and learning of biology (science) and consequently a good performance in students. Ifeakor, Okoli, Nwafor (2010), were of the opinion that learning can occur through one‟s environment – facilities that are available to facilitate students learning outcome. Students can master better, the basic concepts of biology when they learn by doing as suggested by the curriculum. This implies that practical activities should function as the primary learning experience as prescribed by the Senior High School biology curriculum. (German & Aram, 1996; Ayirah, 2015).

2.5 The Importance of Cognitive and Process Skills in Biology Teachers' Instructional Activities in Senior High Schools

A central aspect of the biology curriculum is the concept of profile dimensions that should be the basis for instruction and assessment. Learning may be divided into a number of classes. A student may acquire some knowledge through learning. The student may also learn to apply the knowledge acquired in some new context. The four learning behaviours, "knowledge", understanding", "application" and "process "are referred to as dimensions of knowledge. Knowledge is a dimension; application of knowledge is also a dimension. More than one dimension forms a profile of dimensions.

In biology, the three profile dimensions that have been specified for teaching, learning and testing are:

- Knowledge and Comprehension 30%,
- Application of Knowledge 40%
- Practical and Experimental Skills 30%.

Each of the dimensions has been given a percentage weight that should reflect in teaching learning and testing. The weights indicated, show the relative emphasis that the teacher should give in the teaching, learning and testing processes. The focus of this curriculum is to get students not only to acquire knowledge but also to be able to understand what they have learnt and apply them practically. Combining the three dimensions in teaching would ensure that biology is taught not only at the factual knowledge level but that student also acquire the ability to apply scientific knowledge to issues and problems, and will also acquire the capacity for practical and experimental skills that are needed for scientific problem solving.

A central contribution of the work of Shulman (1987), and his colleagues was to reframe the study of teacher knowledge in ways that included direct attention to the role of content in teaching. This was a radical departure from research of the day, which focused almost exclusively on general aspects of teaching such as classroom management, time allocation, or planning. A second contribution of the work was to leverage content knowledge as technical knowledge key to the establishment of teaching as a profession. Shulman and his colleagues argued that high quality instruction requires a sophisticated professional knowledge that goes beyond simple rules such as how long to wait for students to respond. To characterize professional knowledge for teaching, they developed typologies. Although the specific boundaries and names of categories varied across publications, one of the more complete articulations is reproduced below (Table 1).

Table 1: Shulman's Major Categories of Teacher Knowledge

- General pedagogical knowledge, with special reference to those broad principles and strategies of classroom management and organization that appear to transcend subject matter
- Knowledge of learners and their characteristics
- Knowledge of educational contexts, ranging from workings of the group or classroom, the governance and financing of school districts, to the character of communities and cultures
- Knowledge of educational ends, purposes, and values, and their philosophical and historical grounds
- Content knowledge
- Curriculum knowledge, with particular grasp of the materials and programs that serve as "tools of the trade" for teachers
- Pedagogical content knowledge, that special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding (Shulman, 1987, p.8)

These categories were meant to highlight the important role of content knowledge and to situate content-based knowledge in the larger landscape of professional knowledge for teaching. The first four categories address general dimensions of teacher knowledge that were the mainstay of teacher education programs at the time. For Shulman, they acted as placeholders in a broader conception of teacher knowledge that emphasized content knowledge. The remaining three categories defined content-specific dimensions and together comprised what Shulman referred to as the missing paradigm in research on teaching- "a blind spot with respect to content that characterizes most research on teaching, and as a consequence, most of our state-level programs of teacher evaluation and teacher certification" (Shulman, 1986b, p. 8). At the same time, however, Shulman made it clear that the general categories were crucial and that an emphasis placed on content dimensions of teacher knowledge was not intended to denigrate the importance of pedagogical understanding and skill: "Mere content knowledge is likely to be as useless pedagogically as content free skill" (Shulman, 1987).

The first of the three, *content knowledge* includes knowledge of the subject and its organizing structures (Grossman, Wilson, & Shulman, 1989; Shulman, 1986b, 1987; Wilson, Shulman, & Richert, 1987). The second category, *curricular knowledge,* is "represented by the full range of programs designed for the teaching of particular subjects and topics at a given level, the variety of instructional materials available in relation to those programs, and the set of characteristics that serve as both the indications and contraindications for the use of particular curriculum or program materials in particular circumstances" (Shulman, 1987). The last, and arguably most influential, of the three content-related categories is pedagogical content knowledge. Shulman defined pedagogical content knowledge as: ... the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations- in a word, the most useful ways of representing and formulating the subject that make it comprehensible to others.... Pedagogical content knowledge also includes an understanding of what makes the learning of specific topics easy or difficult: the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons (Shulman, 1986b, p. 7).

Interest in these ideas was immediate and widespread. In the two decades since these ideas were first presented, Shulman"s presidential address (1986) and the related Harvard Education Review article (1987) in Shulman (1987) has been cited in over 1200 refereed journal articles. This interest has been sustained with no less than fifty citations to these two articles in every year since 1990. Perhaps most remarkable is the reach of this work, with citations appearing in 125 different journals representing professions ranging from law to nursing to business and addressing knowledge for teaching preschool through doctoral studies. Much of the interest has focused directly on pedagogical content knowledge. Thousands of articles, book chapters, and reports make use of or claim to study the notion of pedagogical content knowledge in a wide variety of subject areas: science, mathematics, social studies, English, physical education, communication, religion, chemistry, engineering, music, special education, English language learning, higher education, and others. And, such studies show no signs of abating. Rarely does an idea - or a term-catch on at such a scale.

The continuing appeal of the notion of pedagogical content knowledge is that it bridges content knowledge and the practice of teaching, assuring that discussions of content are relevant to teaching and that discussions of teaching retain attention to content (Eminah, 2007). As such, it is the unique province of teachers - a content-based form of professional knowledge. However, after two decades of work, the nature of this bridge remains inadequately understood and the "coherent theoretical framework," called for by Shulman (1987) remains underdeveloped.

Two points are worth making here. First, researchers have failed to establish precise or agreed-upon definitions. Throughout the past twenty years, for example, researchers have used the term "pedagogical content knowledge" to refer to a wide range of aspects of subject matter knowledge and aspects of the teaching of subject matter. It is often unclear how ideas in one subject area relate to those in another subject area, or even whether findings within the same subject take similar or different views of teacher subject matter knowledge. Somewhat ironically, nearly one-third of the articles that cite pedagogical content knowledge do so without direct attention to a specific content area- the very emphasis of the notion- instead making general claims about teacher knowledge, teacher education, or policy.

Secondly, while the work of Shulman and his colleagues was developed from extensive observation of classroom teaching, most subsequent research takes particular domains of knowledge, such as pedagogical content knowledge, as given or uses only logical arguments to substantiate claims about the existence and the role of these domains. Few studies test whether there are, indeed, distinct bodies of identifiable content knowledge that matter for teaching. In particular, the field has done little to develop measures of such knowledge and to use these measures to test definitions and our understanding of the nature and the effects of content knowledge on teaching and learning.

Lacking adequate definition and empirical testing, the ideas are bound to play a limited role in revamping the curriculum for teacher content preparation, in informing policies about certification and professional development, or in furthering our understanding of the relationships among teacher knowledge, teaching, and student learning. Without such work, the ideas remain, as they were twenty years ago, promising hypotheses based on logical and ad hoc arguments about the content people think teachers need.

Science Process Skills

Process skills are defined as a set of broadly transferable abilities to many science disciplines and reflective of the behaviour of scientists. Process skills involve demonstration of practical manipulative skills using tools, machines and equipment for problem solving in science Process skills also involve „the process of observation, classification, drawing, measurements, interpretation, recording, reporting and expected scientific conduct in the laboratory/field (Ministry of Education, Science and Sports (MOESS), 2007, p. xiii).

Diabene (2012) stated that process skills that scientists used for practicing and understanding science could be categorised into two (namely basic process skills and integrated process skills). The basic (Simpler) process skills provide a foundation for learning the integrated (Complex) skills. The basic skills that students are more likely to develop according to the syllabus are planning (defining the problem and thinking of ways to solve it through experimentation or some structured investigation) and observing (use of the senses, the microscope and other tools to make accurate observations of phenomena), Shaw (1993). The rest are manipulating (skilful handling of objects and tools to accomplish a task) and measuring (accurate use of measuring instruments and equipment). The integrated process skills include creative problem-solving (this is a process of analysing a problem and choosing a noble but relevant solution in order to remedy or alter a problem situation) [MOESS, 2007].

Equipping students with the necessary process skills during instruction will forestall the memorisation of facts and rather encourage practical and active participation of all the learning processes that lead to the discovery of new knowledge Finley, Steward and Yaroch (1982). According to Ossei-Anto (1996), once science process skills are acquired they become very powerful means of mastering content. Lee, Hairston, Thames, Lawrence and Harron (2002), also stated that science process skills ensure that students have the meaningful learning experiences. All these give a lifelong experience to the students and condition them favourably to develop interest and have an inclination towards science. Studies focussing on the Science Curriculum Improvement Study (SCIS) and Science- A Process Approach (SAPA) Padilla (1990), indicated that elementary school students, if taught process skills abilities, not only learn to use those processes, but also retain them for future use.

According to Yandilla and Komane (2004), the processes of science or science process skills are methods that scientists employ in their investigations to establish and confirm consistencies in nature. They are used to describe natural structures, functions of structures and events, develop theories and principles and predict new empirical and theoretical laws or principles. Temniz (2007), also defined science process skills as the adaptation of skills used by scientists for composing knowledge thinking of problems and making conclusions.

According to Wellington (1998) (as cited in Rambuda and Fraser, 2004), science process skills are also activities that scientists execute when they study or investigate a problem, an issue or a question. These skills are used to generate content and to form concepts. In addition, Martin, Sexton, Wagner and Gerlovich (1994), also regarded process skills as the way of thinking, measuring, solving problems and using thoughts. This means that thinking and reasoning skills are involved in the investigative teaching and learning strategies. All these should give a lifelong experience to students and condition them favourably to develop interests that have an inclination towards science (Owiredu, 2012).

To have and use science process skills is very essential in learning problem solving. Science process skills ensure that students have meaningful learning experience and they also have great influence on science education. This is because they help students to develop high mental skills such as critical thinking, making decision and problem solving (Lee, Hairston, Thomas, Lawrence, & Herron, 2002; Koray, Köksal, Özdemir & Presley, 2007). Meador (2003), concluded that individuals who developed higher mental processes can think creatively and they can transfer this ability to the other disciplines.

Process skills are the basics to science allowing everyone to conduct investigations and reach conclusions. Process skills tend to last longer than learned content (Owiredu, 2012). Tifi, Natale and Lombardi (2006), believed that process skills are thinking patterns that can be readily transferred to new situations. Science Process skills is vital for students to learn science concepts as it gives students skills required to construct their own knowledge. In the process of learning science, students themselves have to make their own observations, classifications, measurements, predictions and make their own hypothesis (Germann & Aram, 1996).

According to Young (1995), some science educators have argued that teaching students science facts is not as relevant as developing their science process skills; when the skills have been acquired they can learn the knowledge on their own. In other studies, it was found that science process skills developed the creative and critical thinking (Chang, 2001). In addition, studies conducted in the United States reported that, elementary science students who are taught process skills, not only learn to use those process skills, but also retain them for future use (Mei, Kaling, Xingi, Sing & Khoon, 2007). Thus much time should be devoted to activities that enhance or promote the understanding of science concepts and improve science skills. To achieve this, the teaching of science should be done through the use of activity-based approaches, which significantly improve students" acquisition of the science process skills (Beaumont-Walters, 2001).

The significance of the role of process skills in the teaching and studying of science is generally recognised by experts in the field (Al-Sadaawi, 2007). For the teaching and learning of science to be of considerable value, the students must be able to apply their scientific concepts, procedures and attitudes to their wider life or use them in their wider life or use them in their day to day activities. The effectiveness of learning science is to a great extent enhance students learning achievements into an extensive understanding and practical conception of how scientific concepts and principles apply to them personally, to their families, their communities and their nation. A restricted and constricted understanding of science without expertise in the associated scientific skills is an understanding with very limited value. Therefore, students should be initiated into these skills early in their school experience since so much of their success in their subsequent guided studies requires a second understanding and appropriate use of these science process skills (observing, measuring, classifying, inferring, and communicating) Ango (2002).

According to Wilke and Straits (2005), students with stronger foundations in science process skills will be able to use them in other more intensive scientific inquiries and were more likely to be successful in those inquiries. For this reason, instructors should lay emphasis on the teaching and reinforcing of science process skills. Dökme and Aydìnli (2009), found out that the level of students‟ performance on basic science process skills was low and these findings were contrary to their expectations. The following recommendations were made by them to improve poor students understanding and performance on basic science process skills:

a. Science teachers should give their students additional opportunities when they practice activities in class. They should also assist the students to use basic science process skills and get them to be aware of using the skills.
b. Teachers should give attention to hands-on activities including more basic science process skills for their students. Hands-on science is an activity-based science programme, which provides students the opportunity to interact with objectives and materials. Hands- on science activities should be enhanced.

c. Teachers should give their students homework including hands-on activities and encourage them to use basic science process skills.

There are many processes viewed as essential to the understanding of science as inquiry. Science process skills are described as a set of broadly transferable abilities that are foundation of problem solving in science (Chinn & Hemlo-Silver, 2002; Lederman, 2002). It involves the scientific method of problem solving typically referred to as „scientific habit of the mind" (Chinn & Malhotra, 2002). These processes may be grouped into basic and integrated that may not all be taught at a go. Basic skills represent the foundation of scientific reasoning; learners are required to master and before mastering the advanced integrated science process skills that are more different skills for solving problem (Brotherton & Preece, 1995).

In another development, Yeboah (2008), posited that most science educationists emphasized teaching students" science concepts was not as vital as developing their science process skills so that they were able to do things on their own. This would ensure that major problems associated with teaching and studying of science that led to partial understanding of scientific concepts is addressed. However, assessing process skills is not as common as assessing content knowledge, but it can be equally done (Harlen, 1999).

Among science process skills to be engendered in teaching and studying science are measuring, observing, classifying, hypothesizing and formulating models. These scientific reasoning skills as well as skills for planning, communication and self-sufficient learning, develop over time as one is engaged in practical activities. Educators therefore need to have expertise in these process skills so as to impart unto students they teach in order to be equipped with the basic and necessary scientific skills for scientific creation and development (Abass, 2008).

Choji (1992), carried out an investigation of teachers‟ mastery and effective use of the skills of experimentation in Nigerian classrooms. It was realised that students‟ experience with apparatus and experiments had a significant relationship that is higher with their understanding of science and of exploration as a process of science. Germann, Huskins and Auls (1996), also conducted a study to determine how well a number of high school laboratory manuals promote science process skills that involves scientific inquiry. The results revealed that some laboratory manuals were seldomly used in asking students to use their knowledge and experience to pose questions, solve and investigate natural phenomena. In view of this, the learner was able to develop his/her science process skills and patterns that were related to science process skills. Lawson (1995), described seven thinking skills and patterns that were related to science process skills and are essential for scientific inquiry. These skills are:

a. Accurately describes nature
b. Sensing and stating casual questions about nature
c. Recognising, creating and stating alternative hypotheses and theories
d. Generating logical predictions
e. Planning and conducting control experiment to test hypotheses
f. Collecting, organising and analysing relevant experimental and correlational data
g. Drawing and applying reasonable conclusion

Importance of Science Process Skills

Science inquiry skills are scientific process skills when they are applied in the perspective of science. They are general descriptions of logical and rational thinking, which are used in many areas of human enterprise. Science process skills are not exhibited in relation to some science content, but they can relate to the full range of science content and have a vital role in learning with understanding about these contents. It is specifically for this reason that it is important to consider them separately. Learning with understanding involves linking new experiences to previous ones and extending these ideas and concepts to include a progressively wider range of related phenomena. By this, the ideas developed in relation to particular phenomena become linked together to form ones that apply to a wider range of phenomena and so have more explanatory power. Learning with understanding in science involves testing the usefulness of possible explanatory ideas by using them to make predictions or to pose questions, collecting evidence to test the prediction or answer the questions and interpreting result; in other words, using the science process skills. Conceptual learning conceived in this way takes place through the gradual development of ideas that make sense of the experience and evidence available to the learner at a particular time. Knowledge is comprehensive when existing understanding is no longer adequate, the process continues and alternative ideas, offered by the teacher or other students or obtained from other sources may be tested (Asiamah, 2011).

According to Asiamah (2011), the role of process skills in this development of understanding is crucial. If scientific skills are not well-developed and relevant evidence not collected, then the emerging concepts would not help in the understanding of the world around us. It is to be noted that the inclusion of science process skills as part of the curriculum constituted the main goal of science education. However, there is technical difficulty of assessing some of the process skills but the main reason must surely be the inhibiting influence of a view of science education as being concerned only with development of scientific concepts and knowledge.

(Tobin, Kahle & Fraser, 1990). The technical problems can be solved when there is a will to do so. But it is essential to contradict the argument that science education is ultimately about understanding, and using science process skills is only a means to the end, thus, only the end products needs to be assessed. This paid no attention to the value of these skills in precise and ignored the strong case for process skills being included as part of the major aims of science education.

Teachers as Learning Specialists

As professionals in their field, teachers can be expected to process and evaluate new knowledge relevant for their core professional practice and to regularly update their knowledge base to improve their practice and to meet new teaching demands. By investigating the knowledge underlying effective teaching and learning, we are studying how to improve teacher quality. In fact, the main motive for investigating teacher knowledge is to improve student outcomes. On the other hand, to improve teacher quality, it is crucial to understand what teacher professionalism involves. Thus, this study focuses on teacher knowledge as a key factor in teacher professionalism. In other words, the two main themes underlying the study of teacher knowledge are improving student outcomes and teacher professionalism.

Literature highlights many features that characterise expert teachers, which include extensive pedagogical content knowledge, better problem solving strategies, better adaptation for diverse learners, better decision-making, better perception of classroom events, greater sensitivity to context, and greater respect for students. Several studies stress the importance of the knowledge teachers hold, highlighting that in addition to assimilating academic knowledge, student teachers also need to incorporate knowledge derived from experiential and practical experiences in the classroom. Research also shows that variations in ‘opportunities to learn’ in teacher preparation are related to differences in student achievement: teachers from countries that are top performers in PISA and TIMSS tend to have more opportunities to learn content, pedagogical content and general pedagogy (TIMSS, 1998).

While teacher knowledge is certainly a component of teacher professionalism, professional competence involves more than just knowledge. Skills, attitudes, and motivational variables also contribute to the mastery of teaching and learning. Blömeke and Delaney (2012), proposed a model that identifies cognitive abilities and affective-motivational characteristics as the two main components of teachers' professional competence (Figure 3).

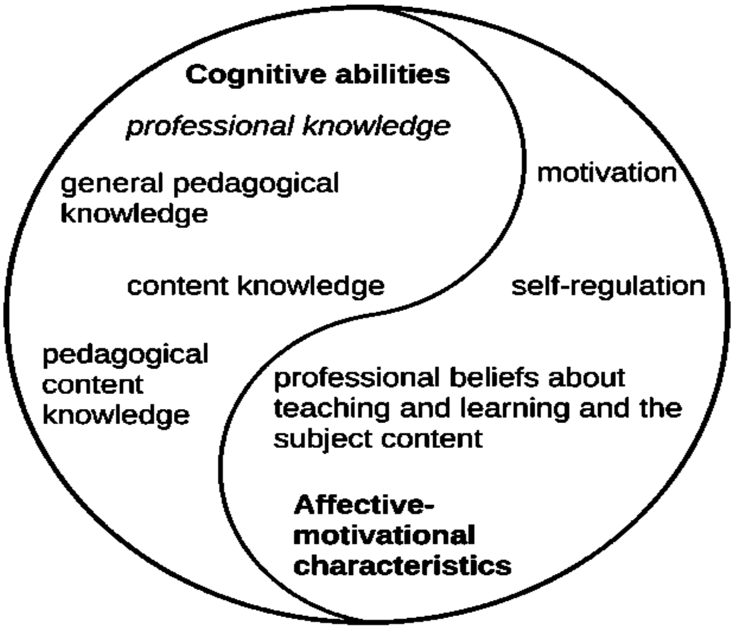

Figure 3: Professional competence of teachers

The Influence of the Teachers' Knowledge on Students' Learning Outcome

Research on the impact of teacher knowledge on student learning outcomes is scarce and the few studies that exist have focused on pedagogical content knowledge or content knowledge. Evidence is beginning to show the following implications: Whereas there is a long history of discussion and debate around the connection between teacher knowledge and quality instruction, there is a lack of empirical research testing this hypothesis or even connecting knowledge to student learning. The studies reviewed show that while much research is still needed to fully support this relationship, as well as to test a cross-cultural conceptualisation of general pedagogical knowledge, research thus far is beginning to show that teachers' general pedagogical knowledge is relevant to understanding quality teaching as understood by its impact on student learning outcomes.

A set of research studies conceptualises the teaching profession as a 'clinical practice profession' and compares it to the medical profession. Some argue that decision-making is actually a basic teaching skill – teachers while processing cognitively complex information about the student in order to decide alternatives for increasing their understanding make decisions regularly.

A review of the different models describing teachers' decision-making shows that factors influencing teachers' decisions include antecedent conditions such as students, the nature of the instructional task, the classroom, and the school environment, which combine with teachers' characteristics and cognitive processes to impact the pedagogical decision made. Decision-making is a cyclic process as pedagogical decisions in turn impact antecedent conditions.

Empirical research investigating how teacher knowledge is used in decision-making seems to be suggesting that in order to make informed pedagogical decisions, teachers must be able to analyse and evaluate specific learning episodes, in combination with contextual and situational factors, and to be able to connect all this information to their specialist knowledge of the teaching-learning process in order to guide subsequent teaching actions. Thus, making good pedagogical decisions hinges on the quality of the pedagogical knowledge held by the teacher.

> "To teach all students according to today"s standards, teachers need to understand subject matter deeply and flexibly so they can help students create useful cognitive maps, relate one idea to another, and address misconceptions. Teachers need to see how ideas connect across fields and to everyday life. This kind of understanding provides a foundation for pedagogical content knowledge that enables teachers to make ideas accessible to others" (Shulman, 1987).

Characteristics of a Collaborative Classroom

Collaborative classrooms seem to have four general characteristics. The first two capture changing relationships between teachers and students. The third characterizes teachers' new approaches to instruction. The fourth addresses the composition of a collaborative classroom.

1. Shared knowledge among teachers and students

In traditional classrooms, the dominant approach for teaching is the teacher as information giver; knowledge flows only one way from the teacher to the student. In contrast, the approach for collaborative classrooms is shared knowledge. The teacher has vital knowledge about content, skills, and instruction, and still provides that information to students. However, collaborative teachers also value and build upon the knowledge, personal experiences, language, strategies, and culture that students bring to the learning situation (Cochran, DeRuiter & King, 1993).

Consider a lesson on insect-eating plants, for example. Few students, and perhaps few teachers, are likely to have direct knowledge about such plants. Thus, when those students who do have relevant experiences are given an opportunity to share them, the whole class is enriched. Moreover, when students see that their experiences and knowledge are valued, they are motivated to listen and learn in new ways, and they are more likely to make important connections between their own learning and "school" learning. They become empowered. This same phenomenon occurs when the knowledge parents and other community members have is valued and used within the school (Hashweh, 2005).

Additionally, complex thinking about difficult problems, such as world hunger, begs for multiple ideas about causes, implications, and potential solutions. In fact, nearly all of the new curricular goals are of this nature--for example, mathematical problem solving--as are new requirements to teach topics such as AIDS. They require multiple ways to represent and solve problems and many perspectives on issues (Grossman, 1990).

2. Shared authority among teachers and students

In collaborative classrooms, teachers share authority with students in very specific ways. In most traditional classrooms, the teacher is largely, if not exclusively, responsible for setting goals, designing learning tasks, and assessing what is learned (Slavin, 1987).

Collaborative teachers differ in that they invite students to set specific goals within the framework of what is being taught, provide options for activities and assignments that capture different student interests and goals, and encourage students to assess what they learn. Collaborative teachers encourage students' use of their own knowledge, ensure that students share their knowledge and their learning strategies, treat each other respectfully, and focus on high levels of understanding. They help students listen to diverse opinions, support knowledge claims with evidence, engage in critical and creative thinking, and participate in open and meaningful dialogue (Resta & Laferriere, 2007).

Suppose, for example, the students have just read a chapter on colonial America and are required to prepare a product on the topic. While a more traditional teacher might ask all students to write a ten-page essay, the collaborative teacher might ask students to define the product themselves. Some could plan a videotape; some could dramatize events in colonial America; others could investigate original sources that support or do not support the textbook chapter and draw comparisons among them; and some could write a ten-page paper. The point here is twofold: (1) students have opportunities to ask and investigate questions of personal interest, and (2) they have a voice in the decision-making process. These opportunities are essential for both self-regulated learning and motivation (Ellis, 2007).

3. Teachers as mediators

As knowledge and authority are shared among teachers and students, the role of the teacher increasingly emphasizes mediated learning. Successful mediation helps students connect new information to their experiences and to learning in other areas, helps students figure out what to do when they are stumped, and helps them learn how to learn. Above all, the teacher as mediator adjusts the level of information and support so as to maximize the ability to take responsibility for learning (Resta & Laferriere, 2007). This characteristic of collaborative classrooms is so important; a whole section is devoted to it below.

4. Heterogeneous groupings of students

The perspectives, experiences, and backgrounds of all students are important for enriching learning in the classroom. As learning beyond the classroom increasingly requires understanding diverse perspectives, it is essential to provide students opportunities to do this in multiple contexts in schools. In collaborative classrooms where students are engaged in a thinking curriculum, everyone learns from everyone else, and no student is deprived of this opportunity for making contributions and appreciating the contributions of others (Ellis, 2007).

Thus, a critical characteristic of collaborative classrooms is that students are not segregated according to supposed ability, achievement, interests, or any other characteristic. Segregation seriously weakens collaboration and impoverishes the classroom by depriving all students of opportunities to learn from and with each other. Students we might label unsuccessful in a traditional classroom learn from "brighter" students, but, more importantly, the so-called brighter students have just as much to learn from their more average peers. Teachers beginning to teach collaboratively often express delight when they observe the insights revealed by their supposedly weaker students (Slavin, 1987).

Thus, shared knowledge and authority, mediated learning, and heterogeneous groups of students are essential characteristics of collaborative classrooms. These characteristics, which are elaborated below, necessitate new roles for teachers and students that lead to interactions different from those in more traditional classrooms.

The Teachers' Roles in Collaborative Classrooms

Teachers are defining their roles in terms of mediating learning through dialogue and collaboration across nations. While mediation has been defined in different ways by Feuerstein and Jenson (1980), Vygotsky (1986), and others, mediation is defined here as facilitating, modelling, and coaching. Most teachers engage in these practices from time to time (Resta & Laferriere, 2007). What is important here are that these behaviours;

(1) drive instruction in collaborative classrooms

(2) have specific purposes in collaborative contexts

Facilitator

Facilitating involves creating rich environments and activities for linking new information to prior knowledge, providing opportunities for collaborative work and problem solving, and offering students a multiplicity of authentic learning tasks. This may first involve attention to the physical environment. For example, teachers move desks so that all students can see each other, thus establishing a setting that promotes true discussion. Teacher may also wish to move their desks from the front of the room to a less prominent space.

Additionally, teachers may structure the resources in the classroom to provide a diversity of genres and perspectives, to use and build upon cultural artefacts from the students' homes and communities, and to organize various learning activities. Thus, a collaborative classroom often has a multiplicity of projects or activity centre's using everyday objects for representing numerical information in meaningful ways and for conducting experiments that solve real problems. These classrooms also boast a rich variety of magazines, journals, newspapers, audiotapes, and videos, which allow students to experience and use diverse media for communicating ideas (Shulman, 1987).

Facilitating in collaborative classrooms also involves people. Inside the classroom, students are organized into heterogeneous groups with roles such as Team Leader, Encourager, Reteller, Recorder, and Spokesperson. (Resta & Laferriere, 2007). Additionally, collaborative teachers work to involve parents and community members.

Another way that teachers facilitate collaborative learning is to establish classrooms with diverse and flexible social structures that promote the sort of classroom behaviour they deem appropriate for communication and collaboration among students. These structures are rules and standards of behaviours, fulfilling several functions in-group interaction, and influencing group attitudes. Particular rules depend, of course, on the classroom context. Thus, teachers often develop them collaboratively with students and review or change them as needed. Examples of rules are giving all members a chance to participate, valuing others' comments, and arguing against (or for) ideas rather than people. Examples of group functions are: asking for information, clarifying, summarizing, encouraging, and relieving tension. To facilitate high quality group interaction, teachers may need to teach, and students may need to practice, rules and functions for group interaction (Shulman, 1987).

Finally, teachers facilitate collaborative learning by creating learning tasks that encourage diversity, but which aim at high standards of performance for all students. These tasks involve students in high-level thought processes such as decision-making and problem solving that are best accomplished in collaboration. These tasks enable students to make connections to real-world objects, events, and situations in their own and an expanded world, and tap their diverse perspectives and experiences. Learning tasks foster students' confidence and at the same time, are appropriately challenging (Shulman, 1987).

Role Model

Modelling has been emphasized by many local and state guidelines as sharing one's thinking and demonstrating or explaining something. However, in collaborative classrooms, modelling serves to share with students not only what one is thinking about the content to be learned, but also the process of communication and collaborative learning. Modelling may involve thinking aloud (sharing thoughts about something) or demonstrating (showing students how to do something in a step-by-step fashion) Shulman (1987).

In terms of content, teachers might verbalize the thinking processes they use to make a prediction about a scientific experiment, to summarize ideas in a passage, to figure out the meaning of an unfamiliar word, to represent and solve a problem, to organize complicated information, and so on. Just as important, they would also think aloud about their doubts and uncertainties. This type of metacognitive thinking and thinking aloud when things do not go smoothly is invaluable in helping students understand that learning requires effort and is often difficult for people (Sockett, 1987).

With respect to group process, teachers may share their thinking about the various roles, rules, and relationships in collaborative classrooms. Consider leadership, for example. A teacher might model what he or she thinks about such questions as how to manage the group's time or how to achieve consensus. Similarly, showing students how to think through tough group situations and problems of communication is as invaluable as modelling how to plan an approach to an academic problem, monitoring its progress, and assessing what was learned (Ellis, 2007).

A major challenge in mediating learning is to determine when it is appropriate to model by thinking aloud and when it is useful to model by demonstrating. If a teacher is certain that students have little experience with, say, a mathematical procedure, then it may be appropriate to demonstrate it before students engage in a learning task. (This is not to say that the teacher assumes or states that there is only one way to perform the procedure. It is also important to allow for individual variations in application). If, on the other hand, the teacher believes students can come up with the procedure themselves, then the teacher might elect or ask the students to model how they solved the problem; alternatively, the teacher could give students hints or cues (Sockett, 2007).

Coach

Coaching involves giving hints or cues, providing feedback, redirecting students' efforts, and helping them use a strategy. A major principle of coaching is to provide the right amount of help when students need it-neither too much nor too little so that students retain as much responsibility as possible for their own learning (Shulman & Shulman, 2004).

For example, a collaborative group of Junior High students worked on the economic development of several nations. They accumulated a lot of information about the countries and decided that the best way to present it was to compare the countries. But they were stymied as to how to organize the information so they could write about it in a paper, the product they chose to produce. Their teacher hinted that they use a matrix-a graphic organizer they had learned-to organize their information. When the group finished the matrix, the teacher gave them feedback. In so doing, he did not tell them it was right or wrong, but asked questions that helped them verbalize their reasons for completing the matrix as they did. The principle the teacher followed was to coach enough so that students could continue to learn by drawing on the ideas of other group members (Ellis, 2007).

Student Roles in a Collaborative Classroom

Students also assume new roles in the collaborative classroom. Their major roles are collaborator and active participator. It is useful to think how these new roles influence the processes and activities students conduct before, during, and after learning. For example, before learning, students set goals and plan learning tasks; during learning, they work together to accomplish tasks and monitor their progress; and after learning, they assess their performance and plan for future learning. As mediator, the teacher helps students fulfil their new roles (Ekici, 2010).

Goal setter

Students prepare for learning in many ways. Especially important is goal setting, a critical process that helps guide many others before-, during-, and after-learning activities. Although teachers still set goals for students, they often provide students with choices. When students collaborate, they should talk about their goals. For example, one teacher asked students to set goals for a unit on garbage. In one group, a student wanted to find out if garbage is a problem, another wanted to know what happens to garbage, a third wanted to know what is being done to solve the problem of garbage. The fourth member could not think of a goal, but agreed that the first three were important and adopted them. These students became more actively involved in the unit after their discussion about goals, and at the end of the unit, could better evaluate whether they had attained them (Meador, 2003).

Designing Learning Tasks and Monitoring

While teachers plan general learning tasks, for example, to produce a product to illustrate a concept, historical sequence, personal experience, and so on, students assume much more responsibility in a collaborative classroom for planning their own learning activities. Ideally, these plans derive in part from goals students set for themselves. Thoughtful planning by the teacher ensures that students can work together to attain their own goals and capitalize on their own abilities, knowledge, and strategies within the parameters set by the teacher. Students are more likely to engage in these tasks with more purpose and interest than in traditional classrooms (Ellis, 2007).

Self-regulated learning is important in collaborative classrooms. Students learn to take responsibility for monitoring, adjusting, self-questioning, and questioning each other. Such self-regulating activities are critical for students to learn today, and they are much better learned within a group that shares responsibility for learning. Monitoring is checking one's progress toward goals. Adjusting refers to changes students make, based on monitoring, in what they are doing to reach their goals. For example, a group of students decided that the sources of information on the Civil War they selected initially were not as useful as they had hoped, so they selected new materials. Another group judged that the paper they had planned to write would not accomplish what they thought it would the way they had organized it, so they planned a new paper (Shulman & Shulman, 2004).

Students can further develop their self-regulating abilities when each group shares its ideas with other groups and gets feedback from them. For example, in a videoconference shown, elementary students were seen collaborating in small groups to define and represent math problems. Working in small groups, the children determined what was being asked in story problems and thought of ways to solve the problems. Then each group shared its ideas with the whole class. Members of the class commented on the ideas. As students developed problem-solving skills with feedback from other groups, they learned more about regulating their own learning, which they could use in the future (Sockett, 1987).

Assessor

While teachers have assumed the primary responsibility for assessing students' performance in the past, collaborative classrooms view assessment much more broadly. That is, a major goal is to guide students from the earliest school years to evaluate their own learning. Thus, a new responsibility is self-assessment, a capability that is fostered as students assess group work (Park & Oliver, 2008).

Self-assessment is intimately related to on-going monitoring of one's progress toward achievement of learning goals. In a collaborative classroom, assessment means more than just assigning a grade. It means evaluating whether one has learned what one intended to learn, the effectiveness of learning strategies, the quality of products and decisions about which products reflect one's best work, the usefulness of the materials used in a task, and whether future learning is needed and how that learning might be realized (Hashweh, 2005).

Collaborative classrooms are natural places in which to learn self-assessment. And because decisions about materials and group performance are shared, students feel freer to express doubts, feelings of success, remaining questions, and uncertainties than when they are evaluated only by a teacher. Furthermore, the sense of cooperation (as opposed to competition) that is fostered in collaborative work makes assessment less threatening than in a more traditional assessment situation. Ideally, students learn to evaluate their own learning from their experiences with group evaluation (Cochran, DeRuiter & King, 1993).

Interactions in a Collaborative Classroom

The critical role of dialogue in collaborative classrooms has been brought to bear. The collaborative classroom is alive with two-way communication. A major mode of communication is dialogue, which in a collaborative classroom is thinking made public. A major goal for teachers is to maintain this dialogue among students (Fernstermacher, 1994).

Consider examples of interactions in collaborative groups. Members discuss their approaches to solving a math problem, explain their reasoning, and defend their work. Hearing one student's logic prompts the other students to consider an alternative interpretation. Students are thus challenged to re-examine their own reasoning. When three students in a group ask a fourth student to explain and support her ideas, that is, to make her thinking public, she frequently examines and develops her concepts for herself as she talks. When one student has an insight about how to solve a difficult problem, the others in the group learn how to use a new thinking strategy sooner than if they had worked on their own. Thus, students engaged in interaction often exceed what they can accomplish by working independently (Sockett, 1987).

Collaborative teachers maintain the same sort of high-level talk and interaction when a whole class engages in discussion. They avoid recitation, which consists primarily of reviewing, drilling, and quizzing; i.e., asking questions to which the teacher knows the answer and there is only one right answer. In true discussion, students talk to each other as well as to the teacher, entertain a variety of points of view, and grapple with questions that have no right or wrong answers. Sometimes both students and the teacher change their minds about an idea. In sum, interactions in whole group discussion mirror what goes on in small groups (Grossman, 1990).

Still a third way interactions differ in collaborative classrooms has been suggested earlier. Teachers, in their new roles as mediators, spend more time in true interactions with students. They guide students' search for information and help them share their own knowledge. They move from group to group, modelling a learning strategy for one group, engaging in discussion with another, giving feedback to still another (Park & Oliver, 2008).

Classroom Control

Collaborative classrooms tend to be noisier than traditional classrooms. This is a legitimate issue for a number of people. Some teachers believe that noisy classrooms indicate lack of discipline or teacher control. In such situations, they argued students could not learn (Shulman, 1987).

Earlier in this review it was stressed that collaborative classrooms did not lack structure. Indeed, structure becomes critical. Students need opportunities to move about, talk, ask questions, and so on. Thus, they argued that the noise in a smoothly running collaborative classroom indicates that active learning is going on. However, students must be taught the parameters within which they make their choices. Rules and standards must be stressed from the beginning, probably before any collaboration is initiated, and reviewed throughout a school year (Johnson & Johnson, 1989).

Preparation Time for Collaborative Learning

Teachers and administrators may believe that new lesson plans must be formed for these classrooms. To a certain extent, they are correct. But many teachers already have created engaging units and activities that are easily implemented in a collaborative classroom. Furthermore, teachers can begin slowly, making changes in one subject area or unit within a subject area, probably one they are already very comfortable teaching, and then add other subjects and units. Teachers can also share their plans with each other. Indeed, if we expect students to collaborate, we should encourage teachers to do the same! Principals and curriculum specialists can also collaborate with teachers to plan effective segments of instruction. Moreover, there is a trade-off between the extra planning time needed and benefits such as less time correcting lessons, increased student motivation, and fewer attendance and discipline problems (Grossman, Wilson & Shulman, 1989).

Individual Differences among Students

This concern has been deliberated in the section on heterogeneous grouping. Nevertheless, many people will still doubt that individual differences can be better addressed in collaborative classrooms than in traditional classrooms with homo-geneous grouping (Johnson & Johnson, 1989).

A major question people have concerns the advantage collaboration affords gifted or high-achieving students. There are two tough issues here. First, many teachers do not believe that low-achieving students have much to contribute to the learning situation; in effect, that they have no prior experiences or knowledge of value. Secondly, teachers worry that high-achieving students would be held back (Grossman, 1990).

In response to the first issue, many collaborative teachers have expressed surprise when seemingly less-able students had insights and ideas that went way beyond what teachers expected. Further, if each student contributes something, the pool of collective knowledge will indeed be rich. In answer to the second concern, data suggest that high-achieving students gain much from their exposure to diverse experiences and also from peer tutoring (Johnson & Johnson, 1989). Also, students who may be high achieving in one area may need help in other areas.

Teachers and others also wonder whether shy students can fully participate in a classroom that depends so much on dialogue. We suggest that these students might feel more comfortable talking in small groups that share responsibility for learning. Furthermore, interaction between learners can happen in ways other than oral dialogue, for example, writing and art (Hashweh, 2005).

A related concern is that many schools are structured homogeneously so that an individual teacher cannot form heterogeneous groups without involving changes in the entire school. One teacher, “averagely” by another, teaches a whole class of “low” readers. High School tracks are even more systematically entrenched. Clearly, these practices are not conducive to collaborative learning and require system-wide restructuring. Individual teachers or groups of teachers can initiate dialogue on the problem, however (Slavin, 1987).

Individual Responsibility for Learning

This concern is a difficult one to solve unless major changes in other areas of schooling are also undertaken. Students are used to being graded for individual work; parents expect to know how their students fare in school. School staff and state departments depend on traditional assessments. In collaborative classrooms, it is often difficult to assign individual grades. Some teachers give group grades, but many students and parents are uncomfortable with these (Ellis, 2007).

Ideally, assessment practices should be changed so that they are consistent with collaboration, with a new view of learning and with a thinking curriculum. In the meantime, effective ways have been developed whereby individual students can be evaluated in collaborative classrooms. For example, (Johnson & Johnson, 1989) as well as (Slavin, 1987) advised in making individuals responsible for subtasks in-group work and then determining both group and individual grades.

Connecting School Learning to Everyday Life

Vygotsky (1986) also provides us with a framework for thinking about an important function of teaching and the multicultural perspective. His research suggests that school learning enables students to connect their "everyday concepts" to "scientific concepts." In other words, schools help students draw generalizations and construct meaning from their own experiences, knowledge, and strategies. Knowledge learned in the community and knowledge gained from school are both valuable. Neither can be ignored if students are to engage in meaningful learning.

Effective teachers help students make these connections by scaffolding and dialogue. In fact, these are the essence of mediating. Teachers plan learning activities at points where students are challenged. Teachers plan activities and experiments that build on the language of students' everyday lives through familiar examples and behaviours, analogies and metaphors, and the use of commonly found materials. Teachers demonstrate, do parts of the task students cannot do, work collaboratively with students where they need help, and release responsibility to students when they can perform the task independently (Vygotsky, 1986).

Cooperative Learning

Cooperation, a form of collaboration, is "working together to accomplish shared goals" (Johnson & Johnson, 1989, p. 2). Whereas collaboration happens in both small and large groups, cooperation refers primarily to small groups of students working together. Many teachers and whole schools are adopting cooperation as the primary structure for classroom learning.

Research strongly supports the advantages of cooperative learning over competition and individualized learning in a wide array of learning tasks. Compared to competitive or individual work, cooperation leads to higher group and individual achievement, higher-quality reasoning strategies, more frequent transfer of these from the group to individual members, more metacognition, and more new ideas and solutions to problems. In addition, students working in cooperative groups tend to be more intrinsically motivated, intellectually curious, caring of others, and psychologically healthy. That is not to say that competition and individual work should not be valued and encouraged, however. For example, competition is appropriate when there can be only one winner, as in a sports event, and individualistic effort is appropriate when the goal is personally beneficial and has no influence on the goals of others (Slavin, 1987).

Unfortunately, simply putting students in groups and letting them go is not enough to attain the outcomes listed above. Indeed, many teachers and schools have failed to implement cooperation because they have not understood that cooperative skills must be learned and practiced, especially since students are used to working on their own in competition for grades. At least three conditions must prevail, according to Johnson and Johnson, if cooperation is to work. First, students must see themselves as positively interdependent so that they take a personal responsibility for working to achieve group goals. Second, students must engage in considerable face-to-face interaction in which they help each other, share resources, give constructive feedback to each other, challenge other members' reasoning and ideas, keep an open mind, act in a trustworthy manner, and promote a feeling of safety to reduce anxiety of all members. Heterogeneous groups of students usually accomplish this second condition better than do homogeneous groups (Ellis, 2007).

The third condition, effective group process skills, is necessary for the first two to prevail. In fact, group skills are never "mastered." Students continually need to reflect on their interactions and evaluate their cooperative work. For example, students need to learn skills both for accomplishing tasks, such as summarizing and consensus taking, and for maintaining group cohesiveness, such as ensuring that everyone has a chance to speak and compromising (Shulman, 1987).

Some people, such as Slavin (1987), have developed specific cooperative learning methods that emphasize individual responsibility for group members. While groups still work to achieve common goals, each member fulfils a particular role or accomplishes an individual task. Teachers can then assess both group and individual work.

Difficult as it may be to implement cooperative learning, those who have are enthusiastic. They see improved learning, more effective social skills, and higher self-esteem for most of their students. In addition, they recognize that our changing world demands more and more cooperation among individuals, communities, and nations, and that they are indeed preparing students for this world (Sockett, 1987).

Teachers' Knowledge of Content for Teaching

What teachers know about the content they teach has been an important area of study in teacher cognition research since the 1980"s: Of particular relevance for the present study is Shulman's (1987), concept of pedagogical content knowledge (PCK). PCK represents the unique nature of teachers' knowledge of content. While teachers possess expert content knowledge of the major facts, theories, and methods of a particular academic field, much as non-teaching content experts would, they additionally possess the knowledge of how to represent particular content in pedagogically appropriate ways to particular students in particular educational contexts. This dynamic integration of knowledge of content, students, pedagogy, and educational contexts is PCK, which constitutes the unique professional knowledge of teachers.

Since its introduction, several modifications and clarifications to the concept of PCK have been proposed. One of the major trends in this research has been a focus on the role of the teacher herself in the transformation of content knowledge and general pedagogical knowledge into PCK. Such studies have focused on how teachers' content-related values, Gudmundsdottir (1990), and beliefs about the purposes and value of studying a particular subject, Grossman (1990), influenced their PCK. These studies demonstrate that the activity of transforming content for teaching is not some clinically rational process. Rather, teachers experience it as fraught with competing values, visions, goals, and emotions that must be delicately balanced.

In addition to the expanded focus on the moral and affective components of teachers' PCK development, Eshun (2014), clarified the nature of the content knowledge teachers transform into PCK. The work of Ball, Thames and Phelps (2008), represented a unique line of research in this vein. Focusing on math education, particularly at the elementary school level, their work empirically investigated the nature of the content knowledge needed for teaching (Ball, Thames, & Phelps, 2008). In particular, the researchers have identified two different categories of content knowledge that the teachers draw on in their work. The first, *common content knowledge* refers to the knowledge that teachers need and use on a regular basis but that is also used in settings outside of teaching. The second category, *specialized content knowledge,* is a particular kind of content knowledge that teachers possess that is not typically used in other settings. However, unlike PCK, *specialized content knowledge* does not directly relate to either a teacher's knowledge of students or of instructional practices. Instead, the authors describe specialized content knowledge as an "unpacked" or "decompressed" form of knowledge (p. 400). An important aspect of developing knowledge for teaching, then, is not only transforming content knowledge into PCK, but also unpacking one's content knowledge to make it available for such transformation.

While the framework of teacher knowledge proposed by Shulman (1987), and subsequently developed by other researchers has been an influential concept in teacher cognition research, it has not been without its critiques. First, critics have argued that research in this framework has largely focused on individual teachers and has not adequately accounted for the role of communities and teaching contexts in teachers' knowledge (Sockett, 1987; Shulman & Shulman, 2004; Ellis, 2007). The second major critique of the PCK framework and subsequent research has been that it reifies knowledge, treating it as static and stable, and as a result has not paid sufficient attention to the teachers' thinking and learning processes (Sockett, 1987, Cochran, DeRuiter, & King, 1993; Fenstermacher, 1994; Hashweh, 2005; Ellis, 2007). This lack of attention to teachers' knowledge development has limited our ability to use PCK as a tool to explicitly scaffold and assess teacher development (Park & Oliver, 2008) and has led to a research agenda that tends to focus "on knowledge at the expense of thinking processes" (Hashweh, 2005, p. 280).

Overall, these two overlapping critiques of the PCK framework point to a need to reconceptualise teachers' subject matter knowledge as dynamic and emergent in the varying professional contexts in which teachers learn and work. There is a need for research that examines teachers' PCK in development, rather than in its more stabilized form, and this research should focus on development through engagement in professional contexts and activities, including teaching practice itself. Unfortunately, little research that examines PCK from this developmental and situated perspective exists. The little research that does examine the development of PCK in teaching practice has been unanimous in highlighting the difficult and uneven nature of such knowledge development. Such studies have emphasized the importance of a strong conceptual framework into which teachers' new insights gained through teaching can be incorporated (Grossman, 1990), but note that this conceptual framework is often lacking due to the limited and inappropriate content preparation many teachers experience (Grossman, Wilson, & Shulman, 1989; Ball, 2000). In particular, the division between content and pedagogy courses present in so many teacher education programs effectively mean that teachers are expected to integrate their knowledge of pedagogy and content independently when they enter the classroom. Unfortunately, research has demonstrated that this integration does not always happen (Ball, 2000; Grossman, 1990). In short, researchers have found that "Learning from experience is neither as automatic nor as effortless as new teachers might like to believe" (Grossman, 1990, p. 109) and that when it does occur it "can be haphazard, dependent to a certain extent on chance" (Grossman, 1990, p. 49).

The influential concept of PCK and its subsequent developments have pushed educational researchers and teacher educators to take teachers' knowledge, and particularly their subject matter knowledge, seriously (Gudmundsdottir, 1990). Yet need remains for studies that do more to examine how PCK develops through teaching activity. Such studies need to account for the dynamic, contextual, emergent, and communal nature of teachers' PCK both as it initially develops in preservice teacher education and crucially as it continues to develop through teachers' on going engagement with the processes of pedagogical reasoning. Such studies may be able to shed light on the difficult and seemingly haphazard process by which teachers learn from their classroom experiences. Understanding what factors contribute to and perhaps hinder such teacher learning can, in turn, inform teacher educators' efforts to prepare teachers for, and support them in, on-going PCK development (Shulman & Shulman, 2004).

In conclusion, the cognitive and process skills displayed by biology teachers during instructional activities cannot be overemphasised. Most of the process skills seen during the classroom activities are suggested by the curriculum prescriptions.

Scientific Inquiry Skills (SIS)

These are a combination of practical and experimental skills that one needs to develop to become a good biologist. In view of the importance of the skills to the biologist, the Senior High School biology curriculum has a unit in almost each section dubbed scientific inquiry skills to help the teacher consciously teach and facilitate certain activities to help students develop these skills (MOE, 2010).

Practical skills involve the demonstration of manipulative skills using tools, machines and equipment for practical problem solving. The teaching of practical skills should involve projects, case studies and field studies where students will be intensively involved in practical work and in search for practical solutions to problems and tasks (MOE, 2010).

Experimental skills involve the demonstration of the inquiry processes in science and refer to skills in planning and designing of experiments, observation, manipulation, classification, drawing, measurement, interpretation, recording, reporting and conduct in the laboratory/field. Practical and experimentation skills refer to the psychomotor domain of profile dimensions (MOE, 2010).

A summary of skills that are required for effective practical and experimental work is as follows: Equipment Handling, Planning and designing of experiments, Observation, Manipulation, Classification, Drawing, Measuring, Interpretation, Recording, Reporting, and Conduct in Laboratory/Field.

This discussion led to the modification of the list of process skills from the original one as discussed during the Barbados workshop:

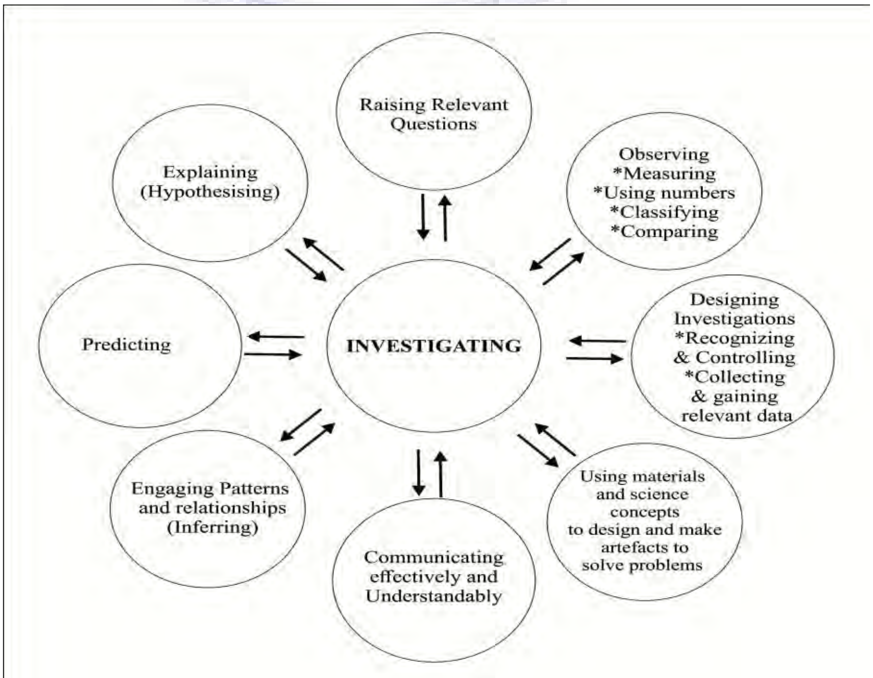

Figure 4: Process skills

To the following:

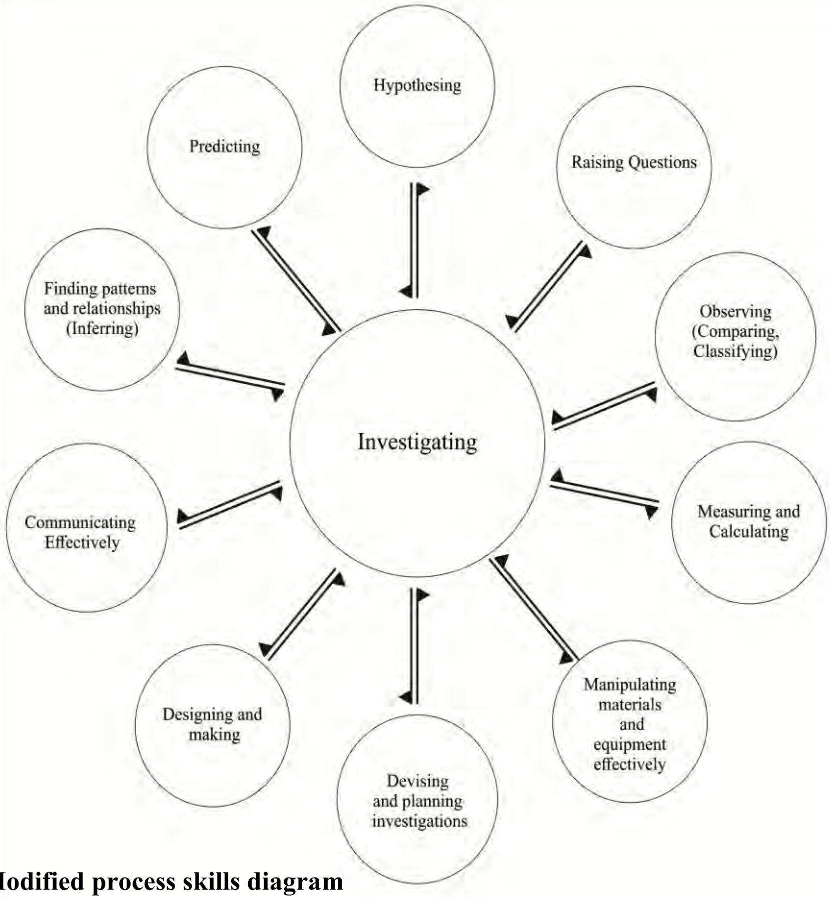

Figure 5: Modified process skills diagram

Observing: Taking in information about all things around, using all the senses as appropriate and safe; identifying similarities and differences; noticing details and sequence; ordering observations.

Raising, question: Asking a variety of questions, through words or actions; gradually recognising questions which can be answered through scientific investigation.

Hypothesising: Suggesting reasons for events or phenomena, which can be tested scientifically; involves applying concepts and ideas from previous experience.

Predicting: Going beyond the immediate evidence, or past evidence, and using this to suggest what will happen at some future time; distinguished from a guess by the appeal to the evidence of present or past observations.

Finding patterns and relationships: Putting several pieces of information together and tasking some sense of the whole, through inferring, identifying trends or correspondences or relationships; drawing conclusions.

Communicating effectively: Being able to present information so that it can be understood by others; being able to understand information from others in various fonts; using graphs, charts, prose, poetry, diagrams appropriately.

Designing and making: Using materials and scientific concepts to create articles and procedures for solving practical problems.

Devising and planning: Investigations Proposing how to find out something through practical manipulation of materials; recognising the variables to be controlled and those to be chanced and how this is to be done; deciding how to collect and record relevant data.

Manipulating materials and equipment effectively: Being able to put into practice the manipulation of objects with- the precision required to obtain useful results; using equipment conventionally but imaginatively.

Measuring and calculating: Using measuring instruments correctly and with appropriate precision as required by the investigation; being able to compute results from measurements taken.

Different curriculum representations and analytical perspectives: Curricula can be represented in various forms. Clarification of those forms is especially useful when trying to understand the problematic efforts to change the curriculum. A common broad distinction is between the three levels of the 'intended', implemented', and 'attained' curriculum. A more refined typology is outlined in Table 2.

Table 2: Typology of Curriculum Representations

INTENDED	Ideal	Vision (rationale or basic philosophy underlying a curriculum)
	Formal/Written	Intentions as specified in curriculum documents and/or materials
IMPLEMENTED	Perceived	Curriculum as interpreted by its users (especially teachers)
	Operational	Actual process of teaching and learning (also: curriculum-in-action)
ATTAINED	Experiential	Learning experiences as perceived by learners
	Learned	Resulting learning outcomes of learners

Besides this differentiation in representations, curriculum problems can be approached from various analytical angles. Goodlad (1994), distinguished the following three different perspectives: substantive, focusing on the classical curriculum question about what knowledge is of most worth for inclusion in teaching and learning; technical-professional, referring to how to address tasks of curriculum development; socio-political, referring to curriculum decision-making processes, where values and interests of different individual and agencies are at stake.

2.6 Perspectives on Curriculum Implementation Approaches

The need to teach biology ultimately must be to explain the living world in terms of scientific principles although appreciating that, organisms behave in ways which often seem beyond the capabilities of their component parts. It is also to guide and inculcate in the learner skills in observing and measuring, formulating hypothesis, predicating and designing, investigating, recording data and interpreting results, drawing conclusions and communicating them.

The knowledge, skills and attitudes acquired through the study of biology is to provide the learner with the necessary basic tools for employment in laboratory, industry, agriculture, horticulture, forestry, health care, work with animals, marine and freshwater biology, information science, administration, finance, management and teaching. It further equips the learner for further studies and research in pure and applied science and technology that are vital areas for the advancement of society. Teaching elective biology in totality guides the learner and makes him/her capable of critical thinking, making meaningful decisions and solving problems.

The GES biology curriculum, was designed to help students to; appreciate the diversity of living things, understand the structure and functions of living things, develop scientific approach to solving personal and societal (environmental, economic and health) problems, develop practical skills required to work with scientific equipment, biological materials and living things, collect, analyse and interpret biological data, and also present data graphically. Additionally, students are to be aware of the existence of interrelationships between biology and other scientific disciplines. The curriculum also seeks to sustain students interest in studying biology, appreciate and understand the interrelationships between organisms and with the environment, recognize the value of biology to society and use it responsibly, develop a sense of curiosity, creativity and critical mind and provide a foundation for those who will develop a career in biological sciences.There are three different perspectives on curriculum implementation that exist in the literature (Snyder, Bolin & Zumwalt, 1992):

- **Fidelity approach:** The curriculum is implemented in accordance with the original intentions of the developers;
- **Mutual adaptation approach**: adaptations of the intended curriculum are made by curriculum developers and practitioners;
- **Enactment approach:** Teachers and students use the curriculum materials as tools to construct their own curriculum in the classroom.

The fidelity perspective is often implied in large-scale curriculum innovations, like in the context of centralised curriculum development systems in African countries. Teachers are supposed to implement the curriculum in line with the developers' intentions. Mutual adaptation suggests a process of negotiation between the developers and teachers in schools. Enactment usually takes place when small groups of teachers and students set out to develop and implement their own curriculum, rather than implement an external curriculum (Snyder, Bolin & Zumwalt, 1992).

Mutual adaptation has emerged as a preferred model by many (Snyder, Bolin & Zumwalt, 1992) because it provides opportunities for adjustments in the curriculum in view of changing needs, interests, beliefs, local circumstances and skills of participants and organisations. The mutual adaptation perspective (as well as the enactment perspective) puts the curriculum development process at the centre of the implementation efforts. Projects reviewed by Snyder *et al.* (1992) and deemed to have been successfully implemented were characterised by a process of mutual adaptation. However, there are also undesirable scenarios of mutual adaptation (Clandinin & Connelly, 2000) such as non-implementation and co-optation. Non-implementation is simply when nothing changes, such as when the process of interaction between a project and an institute breaks down. Co-optation describes the situation in which the innovation is changed to the extent that project design conforms to the usual way of operation at the institution.

Learning and Teaching

The curriculum has an in-built flexibility to cater for the interests, abilities and needs of students. This flexibility also provides a means to bring about a balance between the quantity and quality of learning. Teachers should provide ample opportunities for students to engage in a variety of learning experiences, such as investigations, discussions, demonstrations, practical work, projects, field studies, model-making, case-studies, oral reports, assignments, debates, information search and role-play. Teachers should give consideration to the range of experiences that would be most appropriate for their students. The context for learning should be made relevant to daily life, so that students will experience biology as interesting and important to them.

Practical work and investigations are essential components of the curriculum. They enable students to gain personal experience of science through hands-on activities, and to enhance the skills and thinking processes associated with the practice of science. Participation in these activities encourages students to bring scientific thinking to the processes of problem solving, decision-making and evaluation of evidence. Engaging in scientific investigations enables students to gain an understanding of the nature of science and the limitations of scientific inquiry.

Goals, Objectives, and Outcomes

Most students take biology during the High-School years. It is incumbent on us to re-examine why biology is important for most or all students and what we expect the benefits of biology education to be, both for the individual and for society at large.

Several issues in the field of goals, objectives, and outcomes of biology education will need to be resolved as the committee on High-School biology education addresses its tasks, this can be adapted and also used in the Ghanaian context. "Scientific literacy" has been espoused as a social imperative for a society affected so importantly by science and technology. The American Academy of Arts and Sciences (1983) devoted an entire issue of its proceedings to elaborate the meanings of scientific literacy. That same year, in Educating Americans for the 21st Century (National Science Foundation, 1983), the National Science Board Commission on Precollege Education in Mathematics, Science and Technology "found that virtually every child can develop an understanding of mathematics, science and technology if appropriately and skilfully introduced at the elementary, middle and secondary levels."

The literature is fairly consistent in an affirmation of positive positions on these questions, but in the classrooms in high schools these issues are not settled at all, in stated objectives, actual practice in instruction, or testing and evaluation. Also, coverage of subject matter dominates instruction (Stake & Easley, 1978); it is questionable whether retaining the current breadth of coverage will permit students to attain the other outcomes specified above.

The problems associated with formulating goals, objectives, or outcomes are formidable. First, a national consensus on such a statement would be extremely difficult to attain; and second, evidence seems to support the observation that classroom instruction is determined more often by the textbook used by teachers than by statements of goals in curriculum guides (Stake & Easley, 1978, pp. 13:59-64). The issues implied here have included the question of the target population for High-School biology, its range of content, its context (social, technological, scientific), and its attention to application of knowledge and to the inclusion of higher-order thinking skills. Sorting these issues out is essential and is related to all the other dimensions of the high school biology curriculum.

The study of biology can have a multitude of aims and objectives. Largely, it is studied to allow a learner to enter a specific field of employment. Other aims for studying biology are intellectual, ethical and pragmatic: to increase knowledge about all aspects of organisms, to encourage greater benevolence in the relationship between humans and the natural environment and to implement biological factors into various technologies or management techniques.

Understanding Living Systems and Critical Thinking

The study of biology aims to increase understanding of living systems and to allow learners to consider the systems in relationship to man and other organisms in the natural environment. The goal is to be able to test theories developed about living things by utilizing the scientific method and then to apply the new information in a beneficial way (MOE, 2010).

Field Biology, Health Care and Education

Biology has many applications, both in the natural environment and the environment of health and education. Studying biology allows health care workers to understand the living systems of the body and to apply the knowledge in direct ways to recover and maintain the physical health of both animal and human patients (Rogers & Ford, 1997). Educators rely on biology to teach the study of life to future generations. Field biologists use biology to understand relationships between living organisms and to notice what is beneficial and what is imbalanced and dangerous (Ellis, 2007).

Research

Studying biology prepares learners for a career working in either an educational institution or an industry in which the learners can be directly involved in the research and development of drugs, food-related items and biotechnology. Also, by studying biology you can become qualified to work for the government in managing such things as environmental research of animals, river systems or biological waste (Rogers & Ford, 1997).

Another objective of studying biology is to be able to integrate the fields of technology, law and business with various aspects of biology. Also, by studying biology you learn many of the skills needed to succeed in business and communications, like problem solving and project management. Biology is integrated into computers with bio-informatics and is a part of communications and business with environmental law and eco-products (Chaney, 1995).

Biology is one of the elective subjects in the Key Learning Area (KLA) of science education. The biology curriculum serves as a continuation of the Junior High School (JHS1-3) science curriculum and builds on the strength which are in the current curricula. It would provide a range of balanced learning experiences through which students develop the necessary scientific knowledge and understanding, skills and processes, values and attitudes embedded in the „Life and Living" strand and other strands of science education for personal development and for contributing towards a scientific and technological world. The curriculum will prepare students for entering tertiary courses, vocation-related courses or the workforce in various fields of life science Çimer (2004).

The emergence of a highly competitive and integrated economy, rapid scientific and technological innovation, and a growing knowledge base will continue to have a profound impact on our lives. In order to meet these challenges, the biology curriculum, like other science electives, will provide a platform for developing scientific literacy and building up essential scientific knowledge and skills for life-long learning in science and technology. Through the learning of biology, students will acquire relevant procedural and conceptual knowledge to help them to understand many of today"s contemporary issues, and they will become aware of the interconnections between science, technology and society. In addition, students will develop a respect for the living world, an attitude of responsible citizenship and a commitment to promote personal and community health (Cobbold, 2010).

Biology is a rapidly advancing science with huge amounts of information about living organisms. It is always confused as a subject of memorizing numerous unrelated facts. In this curriculum, it is hoped that students will acquire a limited body of facts and at the same time develop a broad, general understanding of biology principles and concepts. In order to make the study of biology exciting and relevant, it is suggested to introduce the learning of biology in real life contexts. The adoption of diverse learning and teaching strategies, and assessment practices is intended to stimulate interest and create motivation for learning among students with a range of abilities and aspirations (MOE, 2010).

The overarching aim of the biology curriculum is to provide biology-related learning experiences for students to develop scientific literacy, so that they can participate actively in our rapidly changing knowledge-based society, prepare for further studies or careers in the fields related to life science, and become life-long learners in science and technology (MOE, 2010).

The broad aims of the curriculum are to enable students to:

- ❖ Develop and maintain an interest in biology, a sense of wonder and curiosity towards the living world, and a respect for all living things and the environment;
- ❖ Construct and apply knowledge of biology, understand the nature of science in biology-related contexts, and appreciate the relationship between biological science and other disciplines;
- ❖ Develop the abilities to make scientific inquiries; think scientifically, critically and creatively; and solve problems individually and collaboratively in biology-related contexts;

- Understand the language of science and communicate ideas and views on biology-related issues;
- Be aware of the social, ethical, economic, environmental and technological implications of biology, and be able to make informed decisions and judgements on biology-related issues; and
- Develop an attitude of responsible citizenship, and a commitment to promote personal and community health.

The learning targets of the biology curriculum are categorised into three domains: knowledge and concepts, skills and processes, and values and attitudes. Through the learning embodied in the biology curriculum, students will acquire the relevant learning targets in various biology-related contexts (MOE, 2010).

Knowledge and Concepts

Students are expected to:

- Acquire knowledge and develop understanding of biological principles, concepts, terms and facts;
- Develop biological practical techniques and process skills;
- Apply biological knowledge and concepts to familiar and unfamiliar situations;
- Show understanding of the applications and uses of biological knowledge in daily life; and
- Develop an understanding of current issues and developments in biology.

Skills and Processes

Students are expected to:

- Develop abilities to think scientifically and creatively;
- Acquire an analytical mind to critically evaluate biology-related issues;
- Identify the pros and cons of the applications of biological knowledge for informed decision-making;
- Realise the importance of evidence in supporting, modifying or refuting proposed scientific theories;
- Make careful observations, ask relevant questions, identify problems and formulate hypotheses for investigation;
- Plan and conduct scientific investigations individually or collaboratively with appropriate instruments and methods, collect quantitative and qualitative information with accuracy, analyse data and draw conclusions for problem-solving;
- Use information technology to process and present scientific information; and
- Communicate ideas and views effectively with others, using the language of science.

Values and Attitudes Students are expected to:

- Show an interest in the study of biology, appreciate the wonders and complexity of Nature, and show respect for all living things and the environment;
- Be aware of the applications of biological knowledge in society and their social, ethical, economic and environmental implications;
- Be aware of the dynamic nature of the body of biological knowledge, and appreciate the role of science and technology in understanding the living world;

- Recognise their responsibility for conserving, protecting and maintaining the quality of the environment for future generations; and
- Develop positive values and attitudes and a healthy lifestyle.

In summation, according to the results gathered in this study, it is an obvious fact that most biology lessons organised are contrary to the curriculum prescriptions.

2.7 The Effect of Support Services and Capacity Enhancing Activities on Science Teachers' Output

Support services can be explained as the prevention, intervention transition and follow-up services for teachers output in schools. The term academic support may refer to a wide variety of instructional methods, educational services, or school resources provided to students in the effort to help them accelerate their learning progress, catch up with their peers, meet learning standards, or generally succeed in school. When the term is used in educational contexts without qualification, specific examples, or additional explanation, it may be difficult to determine precisely what "academic support" is referring to. The terms support or supports may also be used in reference to any number of academic-support strategies (Smith & Anderson, 1999).

In practice, academic support encompasses a broad array of educational strategies, including tutoring sessions, supplemental courses, summer learning experiences, after-school programs, teacher advisors, and volunteer mentors, as well as alternative ways of grouping, counseling, and instructing students. Academic support may be provided to individual students, specific student populations or all students in a school. The design and purpose of academic-support programmes may vary widely from school to school (Rosebery & Puttick, 1998).

Capacity enhancing activities can be explained as the Needs Analyses methods that essentially identify and determine the type of capacity that needs to be built in teachers. Teacher needs for capacity building could be established in the following ways:

1. Student Assessment: Assessment is an integral part of learning. It helps us determine whether our goals of curriculum are being met or not. Well-designed assessment not only helps a learner demonstrate what she has learnt, but also enables the teachers to understand, "Are we teaching what we think we are teaching?" "Are students learning what they are supposed to be learning?" "Is there a way to teach the subject better, therefore promoting better learning?" (Lord & Miller, 2000).
2. Teacher Assessment: Teachers in many cases are in need of specific feedback - which will provide them insights on where, what and how to improve their own abilities in order to function with effectiveness. Teacher assessments would identify common strengths or weaknesses among teachers, provide feedback to individual teachers on their strengths and weaknesses and improvement areas, and recommend interventions for improvement based on the above (Lord & Miller, 2000).
3. Background questionnaires: Along with teacher assessments, information can be collected through background questionnaires, where teachers can be asked to provide their perception of what they most require to effectively enhance their performance (Lord & Miller, 2000).
4. Focus Group Meetings: Focus group discussions with Teachers, Students, Parents and school management, can be carried out to identify needs for building capacity (Lord & Miller, 2000).

5. Visioning Exercises: These can be used to create vision and build a shared mission in a school. This enables identifying top priorities for the school. In this exercise the team gets to think creatively about their vision by visualising their dream school and articulating the qualities of students who would emerge from this school, and the qualities of teachers who would make this happen. This also enables the teachers to reflect on the profession of teaching (Lord & Miller, 2000).
6. Class Room Observations: are undertaken to understand interactions between the teacher and the class, the class environment, to capture how the tone is set at the beginning of the class, classroom management, lesson planning, any specific teacher activities, assignments, kinds of questions put forth to students, nonverbal behaviour of the teacher, and such other factors. These enable the identification of areas that the teacher is strong in and areas that need improvement (Lord & Miller, 2000).

The teacher needs as revealed by such methods could be used to develop targeted professional development programmes focussing on specific needs.

Effective Teacher Learning Opportunities

The Ghana Association of Science Teachers (GAST) in collaboration with the Ghana Education Service (GES) have been organising annual week-long conferences for science teachers annually. This is a national programme organised as an in-service conference for science teachers (Amoah, 2011). Well-designed opportunities for teacher learning can produce desired changes in their classroom practices; it can also enhance their capacity for continued learning and professional growth, and can in turn contribute to improvements in student learning. In a general sense, a great deal is known about the characteristics of such opportunities for teacher learning. There is a general consensus about these characteristics among researchers and among professional and reform organizations (National Staff Development Council, 2001; American Federation of Teachers, 2001; Elmore, 2002; Knapp, McCaffrey & Swanson, 2003). Among the more rigorous studies of professional development for teachers are those of mathematics reforms in California (Cohen & Hill, 1998, 2001; Wilson, 2003); studies of District #2 in New York City (Elmore & Burney, 1997; Stein & D'Amico, 1998); a longitudinal study of sustained professional development by the Merck Institute for Science Education (Corcoran, McVay, & Riordan, 2003); the National Science Foundation (NSF)-funded studies of systemic reform in mathematics and science (Supovitz & Turner, 2000; Weiss *et al.,* 2003); and evaluations of the federal Eisenhower mathematics and science professional development program (Garet *et al.,* 1999).

Teacher Learning in the Organizational Context of Schooling

For several decades, researchers have reported significant benefits of organizational changes that facilitate teacher collaboration, including increased student achievement in schools characterized by strong patterns of collaboration among teachers (Corcoran, Walker, & White, 1988; Ingersoll, 2003). When teachers work collectively in teams, work groups, or as a department, their efforts can yield important instructional results and measurable effects on student learning (Effah, 2014). Collective work and learning in groups is what Wenger (1998) and other researchers refer to as "communities of practice." A community of practice involves much more than the technical knowledge or skills associated with the work. Members of a community of practice work collectively on core tasks that members learn to execute at increasing levels of proficiency over time, drawing on support and feedback from the group. Common tasks (and the underlying knowledge that supports them) serve as the focal point of the community. In a community of teaching practice, individuals engage in the shared work of teaching. For example, they collaborate in preparing units of study, analysing student work or videotaped lessons, developing assessments, and coaching and mentoring one another.

When teacher teams, work groups, and departments function as communities of practice, numerous studies have shown strong, desirable effects on faculty willingness to implement instructional reforms, teacher relationships with students, and student achievement outcomes. The Bay Area School Reform Collaborative (BASRC) works at the district, school, and classroom levels to promote systematic and continuous education improvement through building and sharing professional knowledge and fostering mutual accountability and collaboration. BASRC evaluators (McLaughlin & Talbert, 2000) reported statistically significant relationships between measures of teacher community and gains in students' SAT-9 scores between 1998 and 2001, as well as strong correlations between teacher community and student survey measures of teacher-student respect, student initiative in class, and students' academic self-efficacy.

Newmann (1996), reported that strong norms of teacher collaboration in schools were associated with more effective implementation of reforms and continuous improvement of practice. They found five elements to be critical to the effectiveness of professional learning groups: (1) shared norms and values (2) focus on student learning, (3) reflective dialogue among teachers, (4) deprivation of practice through public discussions of instructional cases and problems among colleagues, and (5) collaboration on curriculum and instruction (Louis & Marks, 1998). Bryk and Schneider (2002), studied relational trust in schools and found that building social trust among faculty and between faculty and students pays dividends in the levels of engagement around reform initiatives and improved student achievement. They argued that this was especially critical in urban settings, where the work was especially hard. While organizing groups of teachers to work together can result in functional communities that focus their efforts and resources on instructional improvement and teacher learning, merely creating group structures by no means guarantees such positive outcomes. Supovitz (2002) found that simply making structural changes that support school-level teacher groups (e.g., providing release time) may not result in collaboration around instruction or improved pedagogical decisions. McLaughlin and Talbert (2000), reported similar findings in their study of high school departments.

Developing teacher groups focused on improvement of instructional practice requires intentionality and support. For groups to work toward instructional improvement, they require time for individuals to work together, for example, shared planning periods. However, the expectations about the use of this time must also be clear. DuFour (2000), also noted the importance of active leaders who help the group identify critical questions to guide their work, set obtainable goals, monitor progress, and ensure that teachers have relevant information and data (e.g., measures of student learning).

Connecting teachers to work groups, teams, and departments that are focused on instructional reform can be an effective means of improving learning environments for students, but it will require leadership, time, and resources to develop. Collaboration, critique, and analytic discussion of practice are essential aspects of a functional teacher group, but these features are often antithetical to existing school and teacher cultures (Lieberman, 1992).

There is some evidence that the resources needed to develop such groups in schools may be subject matter specific. A study by Spillane (2005), suggested that the resources drawn on by these groups may vary across subjects, be affected by the level of teacher expertise in the subject, and be influenced by teacher perceptions about where expertise lies. Spillane found that elementary school teachers tended to have stronger group affiliations and collaborative activities around literacy. These were somewhat less well developed in mathematics and were least developed in science. He found that teachers believed that the expertise in literacy was available among their colleagues but that to access expertise in mathematics or science they had to go outside the school. As scientific capacity in the K-8 teacher workforce is often quite thin, professional communities that will support science instructional improvement may require recruiting local science teaching experts to work with teachers, or building relationships between schools and other organizations (informal science learning institutions, universities, industry) that have expertise in science and science teaching (Loucks-Horsley *et al.,* 1998). The evidence of science-specific subject matter specialists is less clear. In part, this reflects the lower status of science in the lower grades, where mathematics and language arts are emphasized. Here, as in previous sections, by and large, the research base is not specific to science but was drawn from studies in the context of literacy and mathematics. There may be additional features and challenges of building science teacher teams or work groups, but to date, these are not well documented in the science education literature (Loucks-Horsley *et al.,* 1998).

Professional Development Programmes

Besides the school structures and norms that support quality science instruction, professional development programmes also support teacher learning and instructional improvement. Research on teacher learning in professional development is at an early phase and is arguably lagging in science compared with mathematics and literacy (Borko, 2005). However, there is a handful of case studies (Crawford, 2000; Rosebery & Puttick, 1998; Smith & Anderson, 1999) that described the features of high-quality science teacher professional development that engaged teachers in doing science, as well as some analyses of its impact on instructional practice and student learning. These serve as examples for researchers to build on and as food for thought for policy makers and professional development providers.

Science Specialists

School leaders may opt to invest in a cadre of specialized science educators' science specialists, teacher leaders, coaches, mentors, demonstration teachers, lead teachers rather than, or in conjunction with, organized forms of teacher opportunities to learn described above. We use the term "science specialist" to capture varied arrangements of organizing and distributing teacher expertise (Loucks-Horsley *et al.,* 1998; Lieberman, 1992). District staff or principals may make decisions about how they spend their time and what responsibilities they assume, or science specialists themselves may use their own professional judgment in determining to do so. Subject matter specialist teachers may serve as leaders of groups of teachers-working with individual teachers in classroom settings, working with groups of teachers in professional development settings, or working with teachers, administrators, community members, or students on issues or programmes that indirectly support classroom teaching/learning experiences (Lord & Miller, 2000). Alternately, they may assume instructional duties for a subject, in this case science, for an entire K-5 school or certain grade level. This practice is not common in U.S. elementary schools, although some countries typically rely on science specialists from as early as second grade.

Evidence of the effects of subject matter specialists is limited and the results are mixed. Teacher leaders, for example, were a central component in 14 of 19 districts included in Kim, Crasco, Smithson, and Blank (2001), evaluation of the urban systemic initiatives. In this context, teacher leaders did a range of things, including planning, instruction, and working in the classroom with teachers, as well as organizing and running professional development activities. Kim *et al.,* (2001), found that the urban systemic initiatives had demonstrable effects on teacher practice and student learning outcomes in both mathematics and science. The role of teacher leaders in this sense was correlated with student learning effects. However, it was part of a systemic approach to reform, and specific contributions of the teacher leaders were not identified. Although evidence suggests an important role for teacher leaders in influencing peers' practice and there is correlational evidence of an effect on student learning, there has been little careful analysis of the effects of teacher leaders on student learning. The research does suggest that positive outcomes of teacher leaders are contingent on a carefully crafted role in the education system, as Lord and Miller (2000, p. 8) observed:

> Teacher leadership is part of an entire district infrastructure for mathematics and/or science reform. Districts with coherent curriculum programs, professional development that supports teachers' thoughtful and skilful use of curriculum, accountability systems that hold all teachers and administrators responsible for teaching the curriculum and assessments that provide appropriate measures of what students are expected to learn are most likely to have effective teacher leadership.

No studies examined the use of science specialists who assume instructional duties in grades K-5. Attention is drawn to the fact that science specialists are commonly used internationally from early elementary grades onward. This is a common practice in high-performing nations in international comparisons such as the Trends in International Mathematics and Science Study and the Programme for International Student Assessment (TIMSS, 2008). Using science specialists may be a particularly useful strategy in schools and systems in which current K-5 teachers lack knowledge and comfort with science.

Availability of Specialist Science Teachers

It is important to have specialist science teachers to ensure effective science teaching in schools. Science Community Representing Education (SCORE) (SCORE, 2011) uses „specialism" to refer to the subject knowledge gained by a teacher through their academic and professional qualifications and experience and recommend the use of teachers who are subject specialists. Dudu (2013) and Makgato & Mji (2006), show concern on the problem of lack of qualified science teachers in South African schools. There are a number of studies, which reveal the existence of weak teacher content knowledge (Stols, Olivier, & Grayson, 2007; Taylor & Moyana 2005). The issue of teachers" content knowledge should be addressed in order to ensure quality teaching and learning of science in schools.

In-Service Training/Workshops

Generally speaking, Staff development through Seminars, In-service training or Workshops offer one of the most promising ways for improving classroom instruction. It is an attempt to assist the classroom teachers/lecturers to improve on their teaching strategies, techniques, handle new instructional materials or possessed the necessary information and Skills that are required for effective lesson delivery. In essence the dream of self-reliance, skill acquisition and entrepreneurship through education can only be realized through a well-defined programme. In most cases, staff development activities are organized by an Institution, a corporate body, Associations or Government agency and normally last for a short period of time.

An activity similar to that but which may take a long time period is what is referred to as In-service training education. In this case, workers who are already in the service go on training or course programme in order to update or acquire the intellectual and professional skills that are necessary to discharge their duties more efficiently (Amoah, 2011). It must be mentioned here that the completion of In-service education, in most cases, leads to certification, which qualifies one to a new status (Newberry, 1979). For example, an NCE holder who attends a Degree training course while in the service would later qualify as a Degree holder (a new status), following the completion of the In-service programme.

For nation building, each country has to decide between investing on teachers or ignorance. Across nations, many educators view In-service education as an absolute necessity for quite a number of reasons that is if the classroom teachers are to perform their roles more effectively (Stallings, 1982). Surprisingly, some people who have attended seminars, and or workshops were reported to have come back home disappointed rather than returning with enthusiasm and encouragement to participate in such a programme if called upon again (Loucks & Melle, 1982).

Besides that, attempts made to follow the trends of researches on In-service education showed that the research findings are often speculative, contradictory and often confusing, purposely because the research techniques, the instruments and the groups studied vary greatly in terms of culture (Holly, 1982). According to Jackson

(1978), drawing conclusion and making decisions on the basis of research findings in some studies on staff development can lead to frustration and confusion.

According to Ozigi (1977), In-service training is usually organized to:

(a) Elicit participants‟ reaction to their professional training.

(b) Introduce an innovation or to update knowledge.

(c) Improve skills in the use of the instructional materials.

Desirable Qualities of Science Teachers

With the introduction of new innovation in Science teaching and use of instructional materials to bring about effective learning and retention due to technological advancement, the question which comes to mind is whether the practicing classroom teachers do have the intellectual and professional skills necessary to discharge their duties more effectively. The major reason for having a workshop or In-service training is for serving instructors to bridge important gaps which poor training might have produced under the regular training and or to improve serving teachers‟ knowledge, skills and competencies (Mani, 1978). In their country, Loucks and Melle (1982), reported that at a time, there was a call made that all the unqualified or untrained serving teachers should be encouraged to participate in an In-service education. Unlike in the other discipline, all the science teachers are expected to possess concurrently two competencies:

(1) Technical competency

(2) Personal competency

Technical competency involved skills such as, experimentation, initiative, use of appropriate instructional strategy; observation & problem solving; adequate mastery of the subject contents, foundation of education (philosophy of science teaching) and knowledge of the nature of curriculum and instruction. On the other hand, "personal competency" deals with the teachers" attitudes to work, mode of dressing, behaviour, and perception of his role, professional ingenuity and professional responsibilities.

In his own contribution, Ozigi (1977), maintains that in-service trainings are organized for the following reasons:

i. To increase the participants learning or change their attitudes.

ii. To elicit positive participants" reactions to their professional training.

iii. To introduce an innovation or for general awareness.

iv. To improve skills on instructional techniques and use of teaching materials.

As earlier mentioned, capacity building, and in-service education or training take the form of workshops, seminars or conferences. According to Nwachukwu (2000), among the problems that educators observe in some in-service training or workshops both in the developed and developing countries include;

i. Poor organization and inappropriate content selection.

ii. Wrong timing of the period of the year that is devoted for the exercise to take place.

iii. Attitude of the school authority in not wanting to finance or send many staff on In-service programmes, particularly the teachers.

iv. The meagre salaries that are paid to the teachers presently may not allow many teachers to show interest.

v. Failure of the organizers of the workshops/seminars to relate their programmes to the genuine needs or interests of the participants.

vi. Duration of the workshops/seminars and training may be too long or short for the realization of the programme objectives.

vii. Lack of follow up or evaluation after the exercise to see to the mastery of the subject content or acquisition of the required skill.

Organizing an In-service Training: Developing Professional and Humanistic Skills

From the experience, staff development or capacity building workshops usually offer one of the best ways to improve classroom teaching and learning. In fact, many educators are of the opinion that teachers have to search for the patterns of school organization and management that would give freedom to learners in order to bring about better learning outcomes, (Gordon, 1974; Ibrahim, 2000). That is, to promote better understanding, teachers need to emphasize learner/student centred approach, which permits and encourages students or learners to have enough freedom to select, to participate in activities and make self-evaluation through acquisition of necessary knowledge and skills.

Effective classroom planning and management, therefore consists of controlling teachers" behaviours that tend to produce high-level student involvement in the classroom activities, with minimal interruptions and efficient use of instructional time. In other words, whatever action that is required to stimulate learners thinking, enlarge their imagination, promote initiative, sustain attention, make learning real and enhance teaching and learning process is worth looking at critically (Hurd, 1998).

According to Chaney (1995), just as teachers should reinforce good behaviours in the classroom, it has been argued that teacher training programmes should consider different theories and select appropriately, depending on the situation and the age of the learners. Below are guiding principles:

1. Teachers retraining programmes should emphasize discipline related skills in addition to considering the importance of conducive learning environment. The

reason being that classroom control and management skill remain a problem in schools at all levels. For example, in public schools, students"/teachers ratio or students" population is more diverse than ever before, thus making it difficult for the teachers to know all their students or perhaps to find classroom control/management difficult.

Talking about individual differences, apart from differences in the educational background and aptitude the number of student with emotional or learning problem is increasing. Only in the recent time that the impact of praises, responses or teachers" feedback and effect of micro-teaching on students" performance and learning are getting serious attention and investigation it deserved (Akabue, 1991).

Apart from that, there is indication that many teachers entered the profession with little or no training in school discipline techniques, most especially the non-professionals or HND holders. This could be one of the reasons why disciple problems are common in public schools. In fact, public criticism of schools and the debilitating effect of teacher stress and burn out are closely linked to the problem of students" behaviour (Rudolf & Pearl, 1972). Of course, this is the reason why it is made compulsory for most Post-secondary or Tertiary institutions to offer courses on classroom management and planning and curriculum studies. What is provided in their courses including psychology tends to be either theoretical or academic in nature without providing teachers with the actual competency base.

2. Teachers" preparation programmes should emphasize the coherent relationship between theory and practice. Wolfgang and Glickman (1980), argued that teachers hardly had enough knowledge about content organization (topic selection) and about professional approaches to classroom management to facilitate student learning. The problem facing educational development across the nation is lack of recognition of

the importance and the differences between theory and practice in classroom teaching and learning (Ibrahim, 2000). The overwhelming supply of conflicting theories and techniques often resulted in the teacher not knowing which is to be chosen and when to use them appropriately to alleviate the desired objectives.

For example, where does a teacher begin in the process of making use of Reinforcement, discipline or leadership style/strategic in the classroom? What comes first, rules or relationship? Praise or punishment etc.

3. In all the training programmes, organization of learning activities and use of appropriate teaching techniques should be seen as necessary tools for classroom teachers (Wolfgang & Glickman 1980).

From the above discussion, it means teaching goes beyond standing in front of the students. Apart from the good mastery of the subject matter, the teacher should be able to use appropriate teaching techniques to arouse the students" interest, make learning easier or facilitate teaching and learning.

In summary, to assist developing countries in their efforts to improve educational standard, effort is required to redesign the existing curriculum for a more practical approach that is skill based, coherent and humanistic in nature.

Among the widely used methods of teaching are; Demonstration, Discussion, Dramatization, Problem solving, Field trip, Discovery, Project/assignment method, Team teaching, Simulations and programmed instruction or distance learning

Below are some of the problems associated with the planning and organization of workshops/seminar or in service training.

Problems Associated with In-service Education and Workshops

(a) Finance

Many school authorities seem not to be interested in financing any workshops or attendance of seminars organized for staff mainly because they wanted to maximize profits. This is common among private institutions or schools. At times, the staff that might have been interested sometimes often seem to have complains, of not having enough money to undertake such programmes (due to meagre salary paid to the teachers). For these reasons the school proprietors or authority usually turn down such a demand for attendance of such a programme (Kwakman, 2003).

(b) Needs and Interest of the Participants

Failure of the organizer of the workshop/seminars to relate their programme to needs of the participants often cause discouragement. Of course, many programmes were reported to have been organized for material gains by the organizers without giving adequate attention to the goal/objectives of such programmes or not meeting the needs of the participants (Loucks & Melle,1982).

(c) Individual Differences

Failure to accommodate the differences existing among the participants in terms of age, area of specialization, social status, educational background, sex, etc yields to some of the problems associated with In-service education or workshops. For example, programme content having to do with numeracy are often found to be difficult for staff who are not mathematically inclined and at times many complain of the activities to be below their level or standard (Schneider & Krajcik,2002).

(d) Instructional Materials and Facilities

Many In-service or workshops could not achieve the purpose for which they were organized mainly due to unavailability of instructional materials, inadequate facilities (laboratory) and chemicals for effective teaching and learning. At times, the participants are not encouraged when they do not have enough instructional materials and not permitted to have enough practical activities to encourage observations, problems solving, reporting or transfer of learning (Feldman, 2000).

(e) Area of Focus or subject content.

At times, the focus of the activities may not adhere strictly to the objective or goal of the organizer. This can be due to the time factors, with the participants being given information rather than been allowed to practice what is learned in the classroom. This attitude at times has been reported to lead to frustration among the participants (Ornstein & Hunkins, 1998).

(f) Duration of the Programme

Depending on the area of concern or the objectives of the workshops, seminars and training, the duration may be too long or short for the realization of the objectives, particularly if it involves group discussion or practical work. Experience has shown that the time factor has been a major factor affecting the realization of the goal of some programmes. Even people are known to have requested for more time or days most especially when the participants found the programme activities more interesting and exciting (Sanchez & Valcarcel, 1999).

In support of the above, Nwachukwu (2000), argued that, regardless of the country concerned, the problems are identical and each should endeavour to solve any problems identified immediately or as the need arises.

Change and Teacher Development

It is widely acknowledged that teachers can no longer adhere to their traditional role of transmitting knowledge (Kwakman, 2003) when implementing reform-based curriculum designed to support students" construction of knowledge in science (Schneider & Krajcik, 2002). For many teachers, this means substantial change in their instructional practices: they must create a stimulating learning environment and change their role from lecturer to facilitator of the students" learning processes (Kwakman, 2003).

In most of the cases, teachers need to learn a great deal to be able to enact reform-based curriculum. Traditionally, they attend courses, training, or conferences and read professional journals to refresh and update their knowledge and skills. Educative curriculum materials designed to address their learning is another vehicle to support them on a large scale. However, Kwakman (2003), points out that these traditional professional development activities fall short of helping teachers to teach for understanding rather than rote learning.

When learning new concepts of content and pedagogy, and when taking on new roles, the traditional ways of learning that are characterized by transmission of knowledge do not help teachers. Instead they need to acquire competencies to fulfil their new roles. Kwakman (2003), proposes that the working context is the most suitable place in this respect, as new teaching competencies can only be acquired in practice.

Davis (2002), also emphasizes the importance of experiencing new ways of teaching by actually teaching as the most efficient way for teachers to develop and increase their understanding of the new instructional approaches. Although Feldman (2000), proposed a model of certain conditions that needed to be met to change teaching theories, Davis (2002), also stated that it was possible for teachers" beliefs and attitudes to change as a result of practicing new behaviours. In addition to practicing new behaviours, communication plays a key role in teacher learning and implementation of reform. The opportunities to talk with other educators about the problems they are experiencing and to hear and to talk about the solutions that other teachers have discovered is extremely valuable for teachers. They can share and build on each other‟s ideas, examine diverse approaches, discuss their beliefs about learning and teaching, and workings and failures of new curricula, teaching practices and instructional materials. As a result of such settings, they can further develop effective classroom strategies and approaches, and in turn implement reforms more effectively (Davis, 2002). Therefore, communication opportunities and new decision-making structures need to be created, encouraged, and supported for teachers.

Anderson and Helms (2001), also cited the need for contexts in broader education change endeavours and for moving away from traditional in-service education carried out in isolation. In a similar vein, Sanchez and Valcarcel (1999), stated that special attention has to be paid to designing activities, which lead teachers to reflect on, and question their views and practices. They mention the difficulty of proposing in-service training sessions to teachers who have insufficient motivation to take up such activities.

According to Gwimbi and Monk (2003), in-service education can change a teacher‟s pedagogical knowledge but this new knowledge may not be directly expressed in changed classroom practice. For this reason, Fetters, Czerniak, Fish and Shawberry (2002), emphasized the need for teachers to pilot new active learning strategies in their classrooms and to be supported by evaluative feedback from a variety of sources including peers.

Defining curriculum implementation as a collaborative and emotional effort, Ornstein and Hunkins (1998), also pointed to the vital need for peer support for successful implementation process. They mention opportunities for teachers to work together, share ideas, jointly solve problems, and cooperatively create materials to greatly enhance the probability of successful curriculum implementation. Consequently, Davis (2002), stressed that teachers should be empowered to create new structures, policies, and practices within their school settings to support their collaborations with colleagues and students, the development of goals for change, and their design of and experimentation with innovative instructional and learning practices and assessments.

In conclusion, the studies of Kwakman (2003), Schneider and Krajcik (2002), Davis (2002), Anderson and Helms (2001), Sanchez and Valcarcel (1999), Gwimbi and Monk (2003), Ornstein and Hunkins (1998), Fetters, Czerniak, Fish and Shawberry (2002) and Amoah (2011), highlighted the need to provide teachers with something other than traditional in-service training to bring about change in their classrooms and coordinate curriculum. In addition to teacher development studies, the results of these studies contribute a lot to curriculum implementation studies due to the inextricable link between the two (Hall, 1997). It should always be kept in mind that weak teacher development produces little change in curriculum implementation.

2.8 Gaps in the Literature

The available literature provided information on a lot of studies on science and most specifically biology such as: The status of the teaching of biology in selected Senior High Schools in the Volta Region of Ghana (Ahorlu, 2013), Teaching of biology practical in Senior High Schools: A case study of Agona district (Abass, 2008), A survey of biology practical work in selected schools in the Eastern Region, (Yeboah, 2008), among others. However, there was virtually no specific study, which had thoroughly evaluated the Senior High School biology curriculum in the study area.

On curriculum evaluation, the studies found include an M.Phil. thesis on Evaluation of classroom implementation of elective chemistry programme in selected science and mathematics Colleges of Education in the Volta Region of Ghana by Kumabia (2014); he discussed briefly the chemistry curriculum at the Colleges of Education. Eminah (2007) also evaluated the science curriculum at the Junior Secondary School level. However, the focus of this study was to evaluate the Senior High School biology curriculum in the Central Region of Ghana. The contributions of this study are crucial in adding to the literature on the evaluative intentions of the biology curriculum internationally and specifically in Ghana in filling the knowledge gap. With regards to this study, no study has been conducted at the Senior High School level in biology in this regard. For this reason, this study was designed to determine the extent to which the classroom implementation of the SHS biology curriculum aligned with the curriculum prescriptions.

2.9 Summary

The literature reviewed in this chapter showed that teacher educators and researchers were concerned about what occurred in the classrooms and laboratories. The approach to teaching and learning in general and specifically biology teaching and learning, is merely the transmission of knowledge from an authority (teacher) to passive recipients (learners). This has been seriously criticised and recommendation towards learner-centred approaches to biology teaching and learning given (Khale, 1995).

The findings and suggestions made in the studies reviewed here guided this study in identifying the major points of focus and determining an appropriate means to collect data on the implementation process of the current Senior High School biology curriculum. This study focused on Senior High School curriculum implementation in selected schools in the Central Region. There is a yawning gap in literature on the evaluation of the biology curriculum at the Senior High School level. One comprehensive work by Ahorlu (2013) was on the status of teaching and learning of biology in selected Senior High Schools in the Volta Region of Ghana. No work was found on the evaluation of the Senior High School biology curriculum in the study area. Thus, the focus of this study was very crucial in informing biology teacher educators, biology curriculum designers and policy makers on the current state of SHS biology education in the research area.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter deals with the method and instrument used in acquiring information for the study. Under this chapter, the research design, rationale for the design, population and sampling procedures are covered. It continues with observation schedule, document analysis, instrumentation and pilot testing. Other topics include reliability and validity of the instrument. This chapter ends by focussing on data collection procedure, data analysis and ethical and logistical consideration.

3.1 Research Design

A cross-sectional descriptive survey design incorporating both quantitative and qualitative data collection approaches was used for the study. According to Creswell (2009), the problems addressed by social and health science researchers are complex, and use of either quantitative or qualitative approaches by themselves is inadequate to address this complexity (p.203). He further argues that there is more insight to be gained from the combination of both quantitative and qualitative research than by either form itself.

In support of Creswell"s views, other researchers (e.g. Cohen, Manion, & Morrison, 2011; Greene, Caracelli & Graham, 1989; Strauss & Corbin, 1990) argue that the use of both forms of data and data analysis allow researchers to simultaneously make generalisations about a population from the results of a sample and to gain a deeper understanding of the phenomena of interest. These presentations and synthesis justify the use of both quantitative and qualitative approaches in this study.

The research design employed tools such as questionnaire, interviews and observation as the instruments. The descriptive survey method research design was employed for collecting, analysing, interpreting and reporting data in this research study. This was to give a broader picture in terms of the information gathered. Neuman (2000), argued that, such an approach could be justified in terms of the nature of information gathered. This study intends to gather information with regards to evaluating classroom implementation of Senior High School elective biology curriculum in the Central Region of Ghana.

3.2 Rationale for the Design

Even though research into educational issues has its own individual focus, it cannot be divorced from quantitative and qualitative methodological issues that social science research raise. Hitherto that, there has been a virtual catalogue of arguments for engaging in research of one form or the other as the assumptions underlying quantitative (traditional, positivist, empiricist etc.) and qualitative (naturalistic, interpretive etc.) paradigms are diametrically opposed to each other. The point here however is not to rehearse the debates on the merits and demerits of the two opposing paradigms.

Ampiah (2004), posed two questions, which in his view should constitute the basis for choosing one method or the other. These are "What kinds of information are relevant? and "What kinds of methods are relevant for the particular topic under investigation?" (p.60). Ampiahs‟ contention was that there is no best method in educational research and the method one uses should be suited to the issue or topic being explored. Also, Vulliamy, Stephens and Lewin (1990), have pointed out that the approach to social research does not stem from fundamental philosophical commitments only. Other significant considerations such as the particular purposes of the research and the practicality of various strategies given the circumstances in which the inquiry is to be carried out must not be overlooked.

This study, first of all, sought to evaluate the implementation of the Senior High School biology curriculum in classrooms in the Central Region of Ghana. This called for gathering standardized information by using the same instruments and questions for all participants.

Secondly, the study sought to find out whether there was any relationship between teachers and students attitudes to constraints, practical work and their perception of biology in the laboratory environment. To be able to do this, it was necessary to gather data from a wide population of science students in order to make generalizations about the constraints of teachers and students during the implementation of the biology curriculum in Senior High Schools. To meet these expectations, the cross-sectional survey method was found to be most appropriate for use.

Instead of defending the patterns that would emerge from the survey by appealing to the general case based on judgement derived from a wide experience with no systematic empirical grounding, it was decided that the patterns should be empirically validated. To do this the researcher used qualitative design using an interview. This enabled the researcher to gain further understandings into the factors and variables being investigated, thereby increasing the validity of the research findings.

According to Herriot and Firestone cited in Ampiah (2004), they, argued that a multiple case design has a distinct advantage over a single case design. According to them, the evidence from multiple cases is often considered more compelling and hence the overall study is therefore regarded as being more robust.

It was evident that both quantitative and qualitative methodologies were appropriate and necessary for this study in view of the nature of the research questions posed and the issues that required exploration. The use of mixed methodologies made it possible to get detailed and, in-depth information in order to describe, interpret and make informed judgement concerning teachers" views on the essential functions and organisation of biology curriculum in Senior High Schools and how this influences attitudes and perceptions of students in the classroom. Also the use of qualitative research strategy in a broad framework of a quantitative methodology was aimed at gathering further data from a smaller sample, in addition to data collected using measurement-oriented items.

This study therefore employed a combination of two basic methodologies (qualitative and quantitative) and two basic methods (surveys and in-depth interviews) for data collection. The two methods of different methodological origin and nature were used to:

- Obtain a variety of information on biology teachers and how they implemented the curriculum in the classrooms
- Achieve a higher degree of validity and reliability of data
- Overcome the deficiencies of single method studies

There is however, a major pitfall in the use of cross-sectional survey research study design. The subjectivity of respondents, their opinions, attitudes and perspectives together contribute to a degree of bias. According to Vulliamy, Stephens and Lewin (1990), because of lack of rigour in the collection of qualitative data it is easy for biased views to colour the findings and conclusions. Others have written about the difficulty of establishing reliability and validity. To minimise these shortcomings, multiple sources of evidence were used in this study, which provided multiple measures of the same phenomenon in selected schools. In this way the data in the various schools, classrooms and laboratories could be used to compare and confirm the data collected (Guba & Lincoln, 1985).

Despite the obvious advantages of integrating quantitative data by the use of complementary methodologies, the two methodologies are based on different assumptions. It is therefore possible that such different research techniques could produce different results. This is also a weakness in the use of this design.

3.3 Population

There are two types of population in any study, the target population and the accessible population. According to Amedahe (2002), the target population of a study is the aggregate of cases about which the researcher would like to make generalizations and it is the units from which the information is required and actually studied. In addition, Amedahe (2002), defined the accessible population as the group of individuals that are accessible to the researcher as a pool of research subjects for a study. According to Amedahe (2002), researchers usually sample from an accessible population and hope to generalize to a target population.

The target population comprised all biology teachers and second year biology students in Senior High Schools in Ghana. The target population is the population in research to which the researchers can generalize their findings. The accessible population is a subset of the target population and also known as the study population. It is from the accessible population that researchers draw their samples.

The selection of an accessible population is that a smaller population gives in-depth views of a research. Biology teachers and second year biology students formed this population since they would not be focussing so much on writing their final examination and also might have covered a substantial amount of the biology curriculum. Only form two biology teachers were interviewed and observed, whilst other biology teachers" in the selected schools were given the questionnaire to answer and fill out. The size of the population and amount of error determined the size of a randomly selected sample. A Table (with 95% certainty) provided by Krejcie and Morgan (1970), helped the researcher to determine what the results would have been if the entire population had been surveyed (APPENDIX F).

3.4 Sampling Procedure

Sampling is a procedure of using a small number of items or part of a whole population to make conclusions about the population. Apart from the pragmatic reasons of reduced cost and time saving, sampling enables a researcher to estimate some unknown characteristics of the population and make generalisations (Zikmund, 2003). In taking a sample, two major alternative designs sufficed. The first was probability-sampling design that was based on simple random selection where each population element was given a known non-zero chance of selection ensuring that the sample would be representative of the population (Keppel, 1991). Student respondents were selected through simple random sampling in the six single sex schools in the study. The second was non-probability sampling, which was arbitrary (non-random) and subjective (Cooper & Schindler, 2001). This study employed a probability sampling design. In this design all second year biology students and all biology teachers would have an equal chance of being picked. Probability sampling ensures the law of Statistical Regularity, which states that if on average the sample chosen is a random one, the sample would have the same composition and characteristics as the universe (Kothari, 2004).

A number of sampling techniques were used to obtain a representative sample of the accessible population; these were clustered and stratified sampling. Clustered random sampling is a non- probability sampling technique where subjects are selected because of their accessibility and proximity to the researcher (Castillo, 2009). All Grade A schools in the study were cluster sampled from the Cape Coast Metropolis, Mfantseman and Efutu Municipalities respectively.

Whereas stratified sampling technique is a way of getting an „average" which represents the entire population or everything that exists that somebody wants to count or measure by some logical process before a sample is taken from the population (Amoah, 2011). Stratified sampling involved dividing the population into a number of homogenous groups. Where each group contains subjects with similar characteristics. In this study gender was the criterion used. Stratified random sampling was used to select student respondents in fifteen mixed schools in the study. The sample size for this study (using a finite population of 106 teachers and 354 students, calculated based on visits to the selected Senior High Schools in the Central Region of Ghana) was determined using (controlling any sampling error that may arise during selection) a table by Krejcie and Morgan (1970), in APPENDIX F.

The target population comprised all 58 public Senior High Schools" in the Central Region of Ghana that offered biology. The accessible population, however, consisted of 21 public Senior High Schools in the Central Region of Ghana. Out of this number of 21 schools sampled (seven schools from Grades A, B and C) making up 36% of the accessible population. According to van Dalen (1979), a researcher needs 15-20% of the entire population to authenticate a survey study. The schools were categorised as Grade A, B and C schools based on GES standards. The schools were selected through stratified random sampling from the following districts and municipalities in the region; Abura-Asebu-Kwamankese, Assin North, Assin South, Cape Coast, Efutu, Ekumfi, Komenda-Edina-Eguafo-Abrem, Mfantseman, and Upper Denkyira East.

Form two biology teachers and students were selected as respondents for the study. Student respondents were selected through random sampling in single sex schools and stratified random sampling in mixed schools. Thus, the study eventually used 21 Senior High Schools randomly selected from 58 Senior High Schools. A sample size of 460 was to be drawn from a calculated presumed population size of 7790 of second year biology students in Senior High Schools in the Central Region for the 2016/2017 academic year and 187 biology teachers. The size of the population and amount of error determined the size of a randomly selected sample.

Table 3: 2016/2017 Population of Biology Teachers and Students in the Central Region of Ghana

Gender	Teachers	Students	Total
Male	**133**	2693	2826
Female	54	5097	5151
Total	187	7790	7977

The sample size, according to Kothari (2004), should technically be large enough to give a confidence interval of desired width; as such the size of the sample chosen must be large.

3.5 Observation Schedule

During biology lessons, observations were made in the classroom to find out how the elective biology curriculum was being implemented in the various Senior High Schools under study. That was to identify the normal classroom session factors that influenced the implementation of the elective biology curriculum in the various

Senior High Schools. It was also to be used to determine whether the views expressed by the respondents in both the questionnaires and the interviews were consistent with the outcomes of what the researcher was going to observe. This was to enable the triangulation of data.

There are different types of observational procedures or techniques that have been used to examine effective teaching (e.g. charts, rating scales, checklists, and narrative descriptions). However, the most widely used procedure or research method has been systematic classroom observation, which is based on narrative coding systems (Waxman, 2001). These interactive coding systems allow the observer to record nearly everything that learners and teachers do during a given time interval. These interaction systems are very objective and typically do not require the observer to make any high inferences or judgments about the behaviours they observe in the classroom. In other words, these low-inference observational systems provide specific and easy identifiable behaviours that observers can easily code. For this study, a time of about one minute was used to enable the researcher code a lot of activities, which occur within short intervals of each other (APPENDIX E).

For the purpose of this study, the modified version of the Barbados Workshop Instrument, which was used by Eminah (2007), was adapted. The Barbados Workshop Observation Instrument was originally developed in 1986 at a workshop held in the University of Liverpool, England. The instrument was then used at a workshop, held in the Barbados in 1987 to find out the extent to which pupils used process skills when learning science. The instrument was made up of three forms namely Form 1, Form 2, and Form 3 respectively (APPENDIX E). Form 1 was used to code the behaviour of a group of pupils on activities throughout the lesson by the observer ticking in a box opposite the categorized behaviour within a time interval of two minutes. Form 2 was used to code the behaviour of the teacher (excluding his /her movements). The work of the researcher was just to watch and listen to whatever the teacher did or said, and code him/her as described in Form 1. The researcher coded the teachers‟ movements in class using the third form, Form 3 that is a blank form. The learners‟ group positions were marked with „X‟ and lines were drawn to show routes taken by the teacher as well as pauses along the routes taken by him/her. Pauses made less than two minutes were marked with small dots in a circle. Pauses that lasted between four to six minutes were also indicated with a dot in two concentric circles. For any one lesson, three observers were required with each observer scoring with one of the forms.

The modified version of the Barbados Workshop Observation Instrument adapted for this study consisted of a set of verbal and non-verbal behaviours of both teachers and learners coded as A, B, C, D, and E; the teacher‟s verbal activities/behaviours was categorized under A (that coded from A1 to A7) and B (that is coded from B1 to B10) on Form 1. His/her non-verbal activities/behaviours were also coded under C (from C1 to C7). The students‟ verbal and non-verbal activities/ behaviours were also to be categorized under D (that is coded from D1 to D7) and E (that is coded from E1 to E7) respectively on Form 2.

The verbal activities/behaviours of teachers were to be divided into two parts, A and B. Part A contains items on the cognitive levels of his/her questions. Items in this part were constructed in line with Bloom‟s taxonomy, which demands that questions eliciting knowledge and comprehension responses, be classified as lower cognitive and those requiring application, analysis, synthesis and evaluation classified as higher cognitive. It also consisted of a category of observational questions to reflect the demands of the designated Senior High Schools‟ biology curriculum.

The syllabus requires students to be able to acquire knowledge of basic concepts and apply the knowledge acquired in the course to explain various phenomena in science (MOE, 2010). In addition, behaviours categorized in the part B of the teachers" verbal activities consisted of those specified as procedural principles as well as others characterized as the „lecture" method of lesson presentations.

The non-verbal activities coded from C1 to C7 included items on how the teacher used the chalkboard or recorded students" findings or ideas, performed demonstrations or practical experiments, distributed materials, and gave class exercises.

Students" verbal activities which were coded from D1 to D7 included items on how students answered questions, asked questions related to the topic being taught, asked questions which were not related to the topic being taught, asked for help about procedures among others. Students" non-verbal activities which were coded from E1 to E7 also included behaviours of students on how they performed practical activities, record findings into notebooks, made notes from the chalk board or as the teacher dictated, did class activities, handled equipment during practical lessons and how they presented their findings on the chalkboard.

Eminah (2007), effected some modifications in the original Barbados Workshop Observation Instrument. He modified the coding procedures and some items in Forms 1 and 2 of the original instrument. Form 3 of the original instrument which was meant to follow the teacher"s movement in class, was a blank sheet.

In the modified instrument, the observer was required to show the layout of the students" desks, teacher"s table, chalkboard, doors and windows of the classrooms. The observer was also required to record student group sizes and the teaching and learning materials used by the teacher. The time spent with each student group was also to be recorded (APPENDIX E).

Finally, the students" and the teacher"s behaviours were to be coded at one minute intervals instead of two minutes" interval indicated in the original instrument. This was done because a lot of activities happened within short intervals of each other and if it took so long to code them, anyone who saw the data might not picture well the actual things that went on in the classes observed.

3.6 Document Analysis

This study also considered the analysis of curriculum documents as an important aspect. This is because curriculum documents help in comparing the intended curriculum with the actual implemented curriculum. In the case of this study, the intentions of the designers of the Senior High School biology programme were to be compared with the actual implementations that are made in the various classrooms and laboratories.

As a result, the study obtained documents such as biology syllabus, timetable, students" biology handouts, students" exercise books and scheme of work from the heads of science departments or the teachers of the biology programme. These documents were collected to help structure a routine for data collection and also find out how teachers" in Senior High Schools implement the biology programme. Also, the documents were collected to help find out how the resources available at the Senior High Schools are used for the successful implementation of the biology programme.

3.7 Instrumentation and Pilot-Testing of the Instrument

Pilot-testing of the instruments reduces ambiguity of items and therefore enhances their reliability (Meriwether, 2001). The adapted designed item questionnaire tagged "Evaluating Classroom Implementation of Senior High School Elective Biology Curriculum Questionnaire" (ECISHSEBC) was to be used to collect data from teachers and students. Another instrument to be used was a structured interview in which the specific questions to be asked and the order of the questions were predetermined and set by the researcher. The questions were to be based on a strict procedure and a highly structured interview guide, which was no different from a questionnaire. Observation was the final technique to augment the data collection procedure.

The instruments were pilot-tested with a sample of 6 Senior High Schools‟ (3 from „Well Endowed‟ Senior High Schools‟ and 3 from „Less Endowed‟ Senior High Schools‟). This was to ensure a representation of both rural and urban schools and also ensure that problems were addressed from all angles before the main survey.

3.8 Validity of the Instrument

The data collection instruments included the modified version of Barbados Workshop Observation Instrument used by Eminah (2007), the questionnaire and the interview guide were content validated by the researchers‟ supervisors and other experts in the science department of the University of Education, Winneba. These individuals have considerable knowledge and research experiences. Their comments were used to refine the test items before they were administered.

3.9 Reliability of the Instrument

The reliability of the instrument and structured questions was ascertained using the internal consistency approach. This was to reduce costly mistakes and prevent threat to validity of the research. The Cronbach alpha is the preferred index of reliability measure since Ary, Jacobs and Razarieh‟s (1990), advised that Cronbach alpha be used when measures have multiple-score items in attitude scales.

To determine the reliability of the instrument for this study, both students and teachers‟ questionnaires were pilot tested in six schools representing well-endowed and less endowed schools. This was outside the accessible population. The results from the pilot test enabled the researcher to identify and modify some aspects of the instruments before administering them to the accessible population.

To test for reliability, the study used the internal consistency technique by employing Cronbach‟s Coefficient Alpha test for testing a research tool. Internal consistency of data was determined by correlating the scores obtained with scores obtained from other items in the research instruments. Cronbach‟s Alpha is a coefficient of reliability. It is commonly used as measure of the internal consistency or reliabity of a psychometric test score for a sample of examinees.

The result of correlation is Cronbach‟s Coefficient Alpha, which is valued from 0 and +1. According to Mugenda & Mugenda (2003) as cited in Arthur (2014), the coefficient is high when its absolute value is greater than or equal to 0.7; otherwise it is low. A high coefficient implies high correlation between variables indicating a high consistency among the variables. This study will correlate items in the instruments to determine how best they relate using a Cronbach Coefficient Alpha of 0.8.

3.10 Data Collection Procedure

The researcher collected an introductory letter from the Department of Science Education (APPENDIX G), which were sent to the Regional, Metropolitan/ Municipal or District Directors of Education as well as Heads of Senior High Schools to enable the researcher undertake the study. Teachers"" and students"" consent were sought to participate in the study before the tools were administered.

In order to ensure reliability in an uncontrolled environment, the respondents were informed that the questionnaire and questions are not tests and that their responses were not going to be used to change their status or affect their promotion(s). The researcher by making appointment with some teachers who could not complete the questionnaires were carried out at later dates.

3.11 Data Analysis

Both descriptive and inferential statistics were used to analyse the data. Microsoft Excel and The Statistical Package for Social Sciences (SPSS version 22.0) were used by the researcher to analyse the data. The means, frequencies and standard deviations were calculated using the descriptive statistics function of the software and were presented as tables. The results were thoroughly explained with tables used to answer the research questions.

3.12 Ethical and Logistical Consideration

The study was carried out with funds available and within the time frame without having to compromise on its quality. Ethical considerations included confidentiality of information, names and sources. The researcher encouraged voluntary participation, arising from informed consent. To access the required information, permission was sought from the relevant authorities such as the CRDD, Regional Director of Education, Central Region, Heads of the Senior High Schools (APPENDIX H), teachers and students who formed the integral aspect of this study.

Special emphasis was laid on confidentiality or anonymity of questionnaires and interviews in case of sensitive or gazette data. Permission was also sought for the use of the respondents (teachers and students) voice recordings which were transcribed.

CHAPTER FOUR

RESULTS

4.0 Overview

This chapter deals with the presentations of the analysed data obtained from the respondents in the study. It begins with presentations of the bio data of the respondents and followed by the analysed data. Descriptive statistics such as frequencies, percentages, means and standard deviations were used to analyse the data. Also, factor analysis was used to perform inferential analyses, and to draw conclusions on the research objectives. In all, a total of 460 respondents were captured for the study, comprising 354 students and 106 teachers.

Figure 6 examines the teacher respondents by their grade of school. There was an indication that 43 out of the total teacher respondents of 106 representing 40.57% are from Grade A schools. Again, 43 respondents representing 40.57% are from Grade B schools. Moreover, 20 respondents out of the total representing 18.86% are from Grade C schools.

4.1 Demographic Information on the Teachers

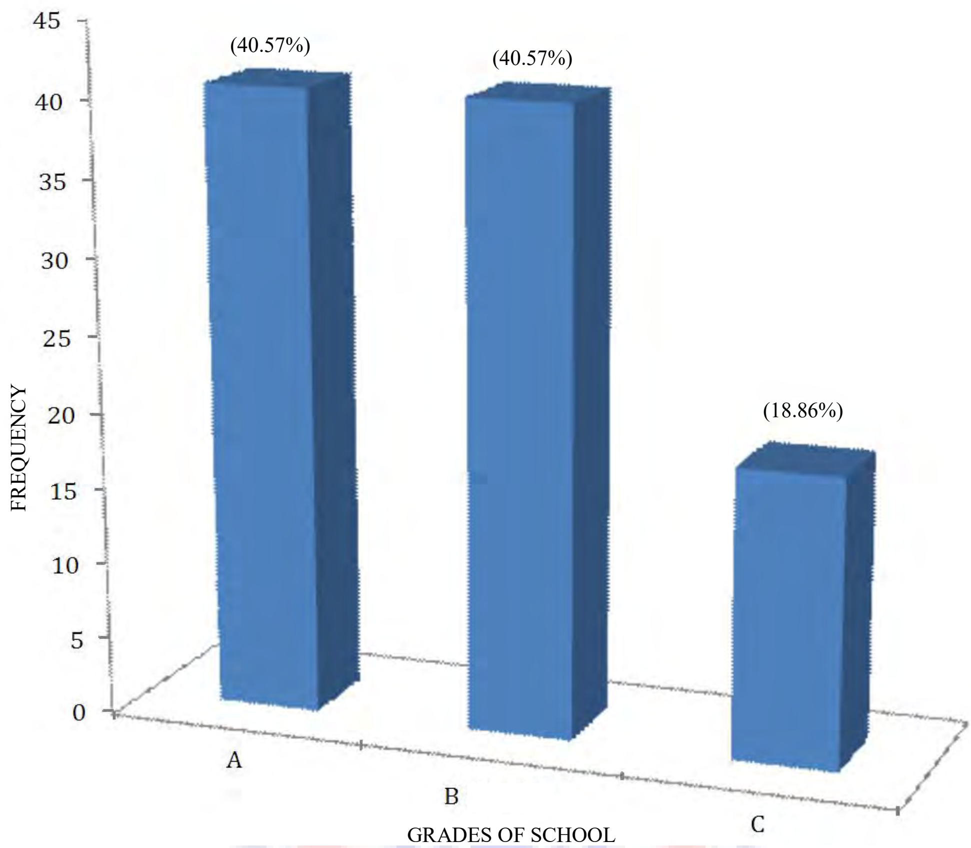

Figure 6: Categorisation of the Senior High Schools

Presentation of the Results by Research Questions

Research Question 1: What are the educational qualifications and areas of specialization of the biology teachers in the selected Senior High Schools?

This research question focused on the academic and professional qualifications of the biology teachers in the selected Senior High Schools as well as their areas of specialization. It also sought to find out their years of teaching experience. The research question was answered with the aid of the items in the bio data section of the questionnaire specifically designed for the purpose.

Figure 7 show the distribution of the respondents by sex. Out of the total sample of 106 respondents, 68 representing 64.15% were male while 38 representing

35.85% were females. This clearly indicates that the teacher respondents were male dominated.

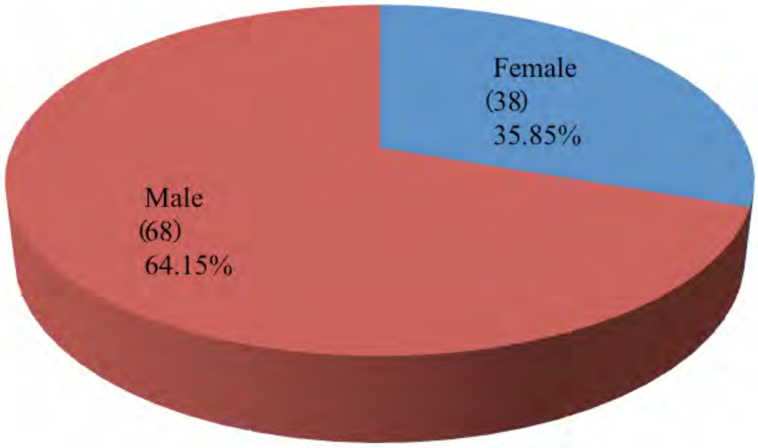

Figure 7: Teacher Respondents by Sex

The results in Table 4 show that out of 106 respondents 7 (6.6%) possessed an M.Phil. degree in Grade A schools. Four (3.7%) M.Phil. holders could also be found in Grade B Schools" whilst none was located in Grade C schools. On the other hand, 8 (7.6%) possessed an M. Ed. degree in Grade A schools whilst 4 (3.7%) were found in Grade B schools. None was recorded in this category for Grade C schools.

Furthermore, 24 (22.65%) of the respondents possess B.Ed. degree(s) in Science specializing in Biology in Grade A schools, 7 (6.60%) were in Grade B schools whilst 10 (9.43%) were also in Grade C schools. Four (3.7%) of B.Sc. with PGDE (Post Graduate Diploma in Education) were in Grade A schools, 4 (3.7%) were also in Grade B schools whilst none was recorded in Grade C schools. In another instance 24 (22.65%) of B.Sc. holders were in Grade B schools, 10 (9.43%) were in Grade C schools whilst none was recorded in Grade A schools.

From Table 4, in Grade A schools most of the teachers were academically and professionally qualified to implement the Senior High School biology curriculum. These statistics are backed with figures and represented in the table as follows; 7

(6.60%) M.Phil. holders, 8 (7.56%) M.Ed. holders, 24 (22.65%) B.Ed. and 4 (3.7%) B.Sc. with PGDE holders.

Also, 4 (3.7%) of the teachers in Grade B schools possessed an M.Phil. or M. Ed. in Science Education, which made them academically and professionally qualified to implement the biology curriculum. Seven (6.60%) of the respondents were B.Ed. Science holders, specializing in biology whilst 4 (3.7%) possessed a B.Sc. but have gone further to acquire a PGDE to augment their professional status. A significant number, thus 24 (22.65%) of the respondents possessed a B.Sc. in various fields such as Agriculture, Animal Husbandry, Environmental Science, Integrated Science, Molecular Biology and Biotechnology just to mention, but a few were also teaching biology in Senior High Schools due to lack of academically and professionally qualified teachers in this regard.

Finally, in Grade C schools, 10 (9.43%) of the respondents possessed B.Ed. in Science specializing in biology, and 10 (9.43%) also possessed B.Sc. in various Sciences which makes such individuals academically and professionally not qualified to implement the Senior High School biology curriculum. With regards to higher degrees such as M.Phil. and M.Ed., none was recorded in Grade C schools, also a B.Sc. with PGDE also recorded 0%.

Table 4: Teachers Academic and Professional Qualifications

Category	Degree	Male		Female		Total	
		Freq.	%	Freq.	%	Freq.	%
A	M.Phil.	7	10.29	0	0	7	6.60
	M.Ed.	4	5.88	4	10.53	8	7.56
	B. Ed.	14	20.59	10	26.32	24	22.65
	B.Sc.+PGDE	0	0	4	10.53	4	3.77
	B.Sc.	0	0	0	0	0	0
B	M.Phil.	4	5.88	0	0	4	3.77
	M.Ed.	0	0	4	10.53	4	3.77
	B. Ed.	4	5.88	3	7.89	7	6.60
	B.Sc.+PGDE	4	5.88	0	0	4	3.77
	B.Sc.	17	25.02	7	18.42	24	22.65
C	M.Phil.	0	0	0	0	0	0
	M.Ed.	0	0	0	0	0	0
	B. Ed.	7	10.29	3	7.89	10	9.43
	B.Sc.+PGDE	0	0	0	0	0	0
	B.Sc.	7	10.29	3	7.89	10	9.43
Total		**68**	**100**	**38**	**100**	**106**	**100**

In Table 5, the number of years the respondents had taught Senior High School biology. There was an indication that the females recorded a mean of 6.45 with a standard deviation of 3.11 whereas, the males recorded a mean of 7.40 with a standard deviation of 6.68. Table 5 further contained the number of years teaching Senior High School biology by the type of school of which there was an indication that Grade C type of school recorded a mean of 4.17 with a standard deviation of 1.83 whereas, Grades A and B school types recorded a mean of 6.79 with a standard deviation of 4.00 and a mean of 9.00 with a standard deviation 7.95 respectively.

Table 5: Number of Years Teaching Senior High School Elective Biology

		Mean	Standard Deviation	Minimum	Maximum
Sex	Male	7.40	6.68	1.00	29.00
	Female	6.45	3.11	3.00	14.00
Type of School	A	6.79	4.00	1.00	16.00
	B	9.00	7.95	1.00	29.00
	C	4.17	1.83	2.00	6.00
	Total	**7.06**	**5.63**	**1.00**	**29.00**

Research Question 2: What resources are available for the teaching and learning of biology in the selected Senior High Schools?

This research question was answered using the responses of teachers and students through several interviews, items in the questionnaire and also through observation of lessons and available equipment, specimen and charts in the laboratories for practical lessons.

From the analysed data, 72.4% of the respondents agreed that their schools had a laboratory for the teaching of biology with a mean level agreement of 3.71 and standard deviation of 1.56. Also, 60.0% of the respondents agreed that there were adequate reading materials available to the students to enhance the study of biology with a mean agreement of 3.39 and standard deviation of 1.42. Again, 44.1% of the total respondents agreed that the teachers in the school had the opportunity to receive professional upgrading towards the teaching of biology with mean agreement level of 3.30 and standard deviation of 1.23. These results have been summarised in Table 6.

Table 6: Resource Available for Teaching Biology

	N Agreement	% Agreement	Mean	Standard Deviation
Is the school well-resourced for the teaching of biology? (Human Resources)	63	37.1	2.71	1.45
Do the facilities in this school promote the teaching of biology? (Material Resources)	71	41.8	2.89	1.45
Does the school have a laboratory for the teaching of biology?	123	72.4	3.71	1.56
Is the laboratory well equipped for the teaching of biology?	70	41.2	2.85	1.53
Are there adequate reading materials (textbooks, handouts, notes etc.) available to you to enhance your study of biology?	102	60.0	3.39	1.42
Is the school library well stocked with biology books for your reference during private studies?	58	34.1	2.61	1.43
Do teachers in this school have the opportunity to receive professional upgrading towards the teaching of biology?	75	44.1	3.30	1.23

Assessment to verify if the data is suitable for factor analysis indicated that, the main issue of concern was the strength of the relationship among the variables or items for indicators of outcomes of resource for teaching biology. Thus, Kaiser-Meyer-Olkin Measure (KMO) of Sampling Adequacy and Bartlett's Test of Sphericity were used. From Table 7, the KMO of .825 and a Bartlett's Test of Sphericity being statistically significant at 0.05 support the factorability of the data set (Dampson & Ofori, 2011). Meaning, factor analysis is appropriate for extracting the latent factors for indicators of outcomes of resources for teaching biology. These results have been summarised in Table 7.

Table 7: Test of Suitability of Factor Analysis for Resource for Teaching Biology

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.825
Bartlett's Test of Sphericity	Approx. Chi-Square	523.611
	Df	21
	Sig.	.000

From the scree plot in Figure 8, there was a clear break or there is a change (or elbow) in the shape of the plot, which is on factor two. Based on this, two factors would be extracted to represent the resources for teaching elective biology.

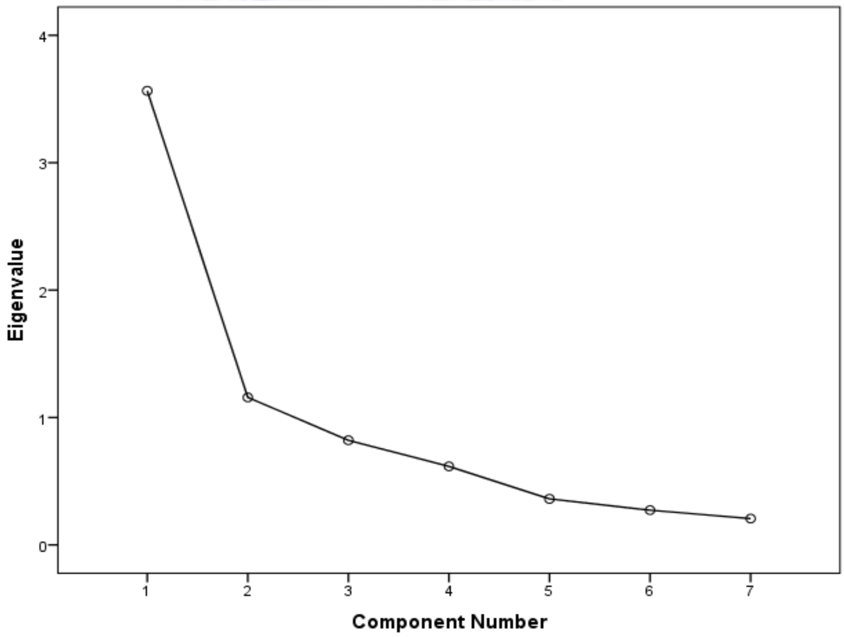

Figure 8: Scree plot on the resource for teaching elective biology factors

After assessing the factorability of the data on indicators of resources for teaching biology in schools, a decision was made concerning the number of factors to extract. However, Kaiser's criterion or Eigen value rule was used to decide on the number of factors to extract. Thus, two factors, which explain 67.453% of the variation of perceived outcomes of resources for teaching biology in schools with greater eigenvalues, were to be extracted to represent the indicators of the outcomes of resources for teaching biology in schools. Thus, two latent factors would be extracted to represent perceived outcomes of the resources for teaching biology in schools. These results have been summarised in Table 8.

Table 8: Eigenvalues for the Resources in Teaching Elective Biology Factors

	Initial Eigenvalues		
Component	**Total**	**% of Variance**	**Cumulative %**
1	3.564	50.916	50.916
2	1.158	16.537	67.453
3	.821	11.732	79.185
4	.616	8.805	87.990
5	.361	5.163	93.152
6	.273	3.894	97.046
7	.207	2.954	100.000

Extraction Method: Principal Component Analysis

From Table 9, the first factor would be named as technical resource, and the second factor would be named as material and human resource. The first factor was made up of four outcomes, namely, "Is the school well-resourced for the teaching of biology?" "Do the facilities in this school promote the teaching of biology?" "Does the school have a laboratory for the teaching of biology?" and "Is the laboratory well equipped for the teaching of biology?" They are the factors that pertain to equipment or infrastructure in schools. The second factor were made up of three outcomes, namely, "Are there adequate reading materials (textbooks, hand-outs, notes etc.) available to you to enhance your study of biology?" "Is the school library well stocked with biology books for your reference during private studies?" and "Do teachers in this school have the opportunity to receive professional upgrading towards the teaching of biology?" They are those that have to do with human development with regards to teachers and material needs of students.

Table 9: Latent Factors for Resource for Teaching Elective Biology

	Component		
	1	**2**	**Extraction**
Is the school well-resourced for the teaching of biology?	.815	.292	.749
Do the facilities in this school promote the teaching of biology?	.823	.325	.784
Does the school have a laboratory for the teaching of biology?	.849	-.020	.721
Is the laboratory well equipped for the teaching of biology?	.857	.315	.833
Are there adequate reading materials (textbooks, handouts, notes etc.) available to you to enhance your study of biology?	.180	.759	.609
Is the school library well stocked with biology books for your reference during private studies?	.108	.836	.710
Do teachers in this school have the opportunity to receive professional upgrading towards the teaching of biology?	.192	.528	.316

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 3 iterations.

From Table 10, results showed that out of 106 respondents, 100 representing 94.3% used the textbook Biology for Senior High School (GAST) for teaching and learning biology followed by 5 respondents representing 4.7% used the Modern Biology textbook for teaching and learning biology. Also, only 1 respondent representing 0.9% used Functional Approach textbook for teaching and learning biology. However, 88 respondents out of the total respondents representing 83.0% indicated that they had a current syllabus for use in their school whiles 18 respondents representing 17.0% indicated that they do not have the current syllabus for use in their school.

Table 10 further examined how accessible the biology curriculum was to the teacher. There was an indication that 67 respondents representing 63.2% had a copy of the syllabus. Also, 25 respondents out of the total of 106 respondents representing

23.6% and 14 respondent representing 13.2% used the GAST textbook in place of the syllabus and some teachers always had a copy available for reference. None of the respondents indicated that they do not teach without reference to the syllabus. Moreover, 58 (54.7%) respondents stated that the content of the biology syllabus available to the teachers was partially in line with the recommended textbooks followed by 43 respondents representing 40.6% indicating that the contents were completely in line with the recommended textbooks. Finally, 5 (4.7%) respondents indicated that the contents of the biology syllabus are not in line with the available recommended textbooks.

Table 10: Availability of biology curriculum and textbooks

		Male		Female		Total	
		Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**
What are the textbooks available for teaching and learning biology?	Modern biology	1	1.6	4	9.5	5	4.7
	Functional approach	0	0.0	1	2.4	1	.9
	Biology for SHS (GAST)	67	98.4	33	88.1	100	94.3
Do you have a current syllabus for use in your school?	Yes	64	95.3	24	64.3	88	83.0
	No	4	4.7	14	35.7	18	17.0
How accessible is the biology syllabus to you?	I have a copy myself	46	68.8	21	54.8	67	63.2
	A copy is always available for reference	1	1.6	13	31.0	14	13.2
	I use the GAST textbook in place of the syllabus	20	29.7	5	14.3	25	23.6
	I teach without reference to the syllabus	0	0.0	0	0.0	0	0.0
Are the contents of the biology syllabus available to you in line with the recommended textbooks?	Not in line	5	7.8	0	0.0	5	4.7
	Partially in line	36	53.1	22	57.1	58	54.7
	Completely in line	27	39.1	16	42.9	43	40.6
	Total	**68**	**100.0**	**38**	**100.0**	**106**	**100.0**

Analysis of data from the interview schedule responses from teachers indicated whether their schools were well equipped with both human and material resources for the teaching of biology. From Table 11, responses showed that some schools were privileged to have both human and material resources available and this was indicated as 42 (39.6%) in grade A schools. For the next category of responses thus, human resource and material resource were 32 apiece and of the same percentage thus 30.2% in grades B and C schools respectively.

Table 11: Human and Material Resource Availability

Category Of School	Response	Frequency	Percentage (%)
Grade B & C	Human resource	32	30.2
Grade B & C	Material resource	32	30.2
Grade A	Both resources (human+ material)	42	39.6
Total		**106**	**100**

In another instance, responses, from students were also collated and analysed. Students were asked whether they had a laboratory for biology lessons. From the results in Table 12, students" responses indicated that 220 (62.1%) stated that they had biology laboratories in their school for the organisation of practical lessons. Also, 134 (37.9%) of the students indicated that there were no biology laboratories in their schools.

Table 12: Biology Laboratory Facilities in Schools

Responses	Frequency	Percentage (%)
Yes	220	62.1
No	134	37.9
Total	**354**	**100**

In another vein, students interviewed were asked if they had a laboratory for biology lessons, they were then asked to show how often they went there for practical lessons, the responses have been collated in Table 13. Results from Table 13 indicated that 154 (43.5%) of students reported that their teachers did not conduct practical lessons for them, 80 (22.6%) of students stated that they were taken through some practical lessons once in a term. Also 75 (21.2%) of students indicated that they had biology practical lessons monthly, whilst 25 (7.1%) of students indicated that they had their practical lessons fortnightly. A rather small number of 20 (5.6%) stated that they had biology practical lessons weekly.

Table 13: Frequency of Practical Organisation

Time(s)	Frequency	Percentage (%)
Weekly	20	5.6
Fortnightly	25	7.1
Monthly	75	21.2
Termly	80	22.6
No practical	154	43.5
Total	**354**	**100**

Finally, biology students were asked if they had laboratory technicians in their schools‟. It was found that 225 (63.6%) of students indicated that there were no laboratory technicians in their schools. Again, 129 (36.4%) of the students indicated that laboratory technicians were in their schools as indicated in Table 14.

Table 14: Availability of Laboratory Technicians in Schools

Responses	Frequency	Percentage (%)
Yes	129	36.4
No	225	63.6
Total	**354**	**100**

Research Question 3: Which of the cognitive and process skills specified in the biology curriculum are reflected by the teachers' instructional activities?

This research question was answered using some items in the teachers‟ questionnaire and some items in the interview schedule as well as data from the class observations. Results from Table 15, showed that 86.5% of the respondents were always allowed to ask questions to aid their understanding of concepts followed by 36.5% of the total respondents indicating that the teacher always involved them in practical activities. Also, 44.1% of the respondents showed that the students sometimes worked in groups with others on the various topics followed by 31.8%

respondents indicating that they sometimes read biology textbooks/hand-outs and made their own notes. However, 74.1% respondents always copy the notes that the teacher dictated/wrote on the board whiles 75.9% of the total respondents indicated that their teacher always marked their quizzes and class exercise on time and gave them feedback accordingly.

Table 15: Classroom Activities on the Implementation of the Biology Curriculum

	Never %	Rarely %	Sometimes %	Most of the time %	Always %
I am allowed to ask questions to aid my understanding of concepts	.6	.6	2.9	9.4	86.5
The teacher involves me in practical activities	3.5	7.1	34.1	18.8	36.5
I work in groups with other classmates	7.1	14.7	44.1	16.5	17.6
I hold discussions with others on the various topics	6.5	15.9	47.6	20.0	10.0
I read biology textbooks/hand outs and make my own notes	9.4	7.1	31.8	24.7	27.1
I copy the notes that the teacher dictates/writes on the board	1.8	4.7	6.5	12.9	74.1
Enough time is allocated on the school time table for the teaching and learning of biology	10.0	7.1	8.2	12.9	61.8
The teacher allows me to handle materials and equipment during practical lessons	7.6	8.8	21.2	15.3	47.1
The teacher uses various tools (quizzes, exercise, assignment, projects etc.) to assess my work	0.0	2.9	8.8	13.5	74.7
The teacher marks my quizzes and class exercises on time and gives me a feedback accordingly	1.2	1.8	6.5	14.7	75.9

The Kaiser-Meyer-Olkin Measure (KMO) of Sampling Adequacy and Bartlett's Test of Sphericity were used for factor analysis assessment. From Table 16, the KMO of .641 and a Bartlett's Test of Sphericity being statistically significant at 0.05 support the factorability of the data set (Dampson & Ofori, 2011). Meaning that, factor analysis was appropriate for extracting the latent factors for indicators of outcomes of classroom activities and teaching biology.

Table 16: Test of Suitability of Factor Analysis for Classroom Activities

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.641
Bartlett's Test of Sphericity	Approx. Chi-Square	246.703
	Df	55
	Sig.	.000

From the scree plot in Figure 9, there was a clear break or there was a change (or elbow) in the shape of the plot, which was on factor three. Based on this, three factors were extracted to represent the teaching of biology in schools.

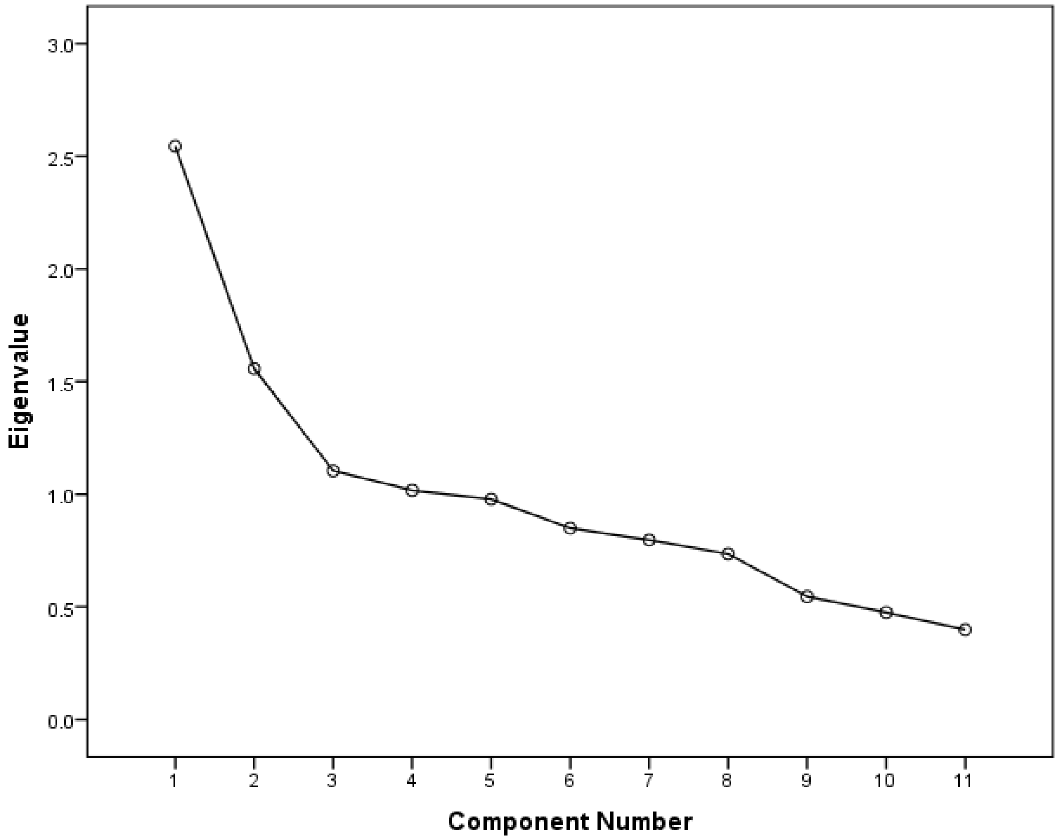

Figure 9: Scree plot for indicators of classroom activities

After assessing the factorability of the data on indicators of teaching biology in schools, a decision had to be made concerning the number of factors to extract. However, Kaiser's criterion or Eigen value rule again was used to decide on the number of factors to extract. Thus, three factors, which explain 47.329% of the variation of perceived outcomes of teaching biology in schools with greater eigenvalues, were extracted to represent the indicators of the outcomes of teaching biology in schools. Thus, three latent factors were extracted to represent perceived outcomes of teaching biology in Senior High Schools.

Table 17: Eigenvalues for Indicators of Classroom Activities

Component	Initial Eigenvalues Total	% of Variance	Cumulative %
1	2.544	23.131	23.131
2	1.558	14.159	37.290
3	1.104	10.040	47.329
4	1.017	9.244	56.574
5	.978	8.890	65.464
6	.849	7.717	73.181
7	.796	7.240	80.422
8	.735	6.679	87.100
9	.545	4.958	92.059
10	.475	4.319	96.377
11	.398	3.623	100.000

Extraction Method: Principal Component Analysis.

From Table 18, the first factor would be named as teacher-learner activities, the second factor would be named as mode of assessments and the third would be named as time allocation. The first factor was made up of six outcomes, namely, "The teacher allows me to handle materials and equipment during practical lessons", "The teacher involves me in practical activities", "The teacher makes use of sufficient resources (pictures, tables, animations, computers etc.)", "I work in groups with other classmates", "I hold discussions with others on the various topics" and "I am allowed to ask questions to aid my understanding of concepts". They are the factors that pertain to activities between the teacher and the students. The second factors were made up of two outcomes, namely, "The teacher uses various tools (quizzes, exercise, assignment, projects etc.) to assess my work", "The teacher marks my quizzes and class exercises" on time and gives me a feedback accordingly" and "I copy the notes that the teacher dictates/writes on the board". They are those that have to do with mode by which teachers assess students. However, the outcome, "I copy the notes that the teacher dictates/writes on the board", is more of teacher-learner activity factor, was also removed. Therefore, the mode of assessment factor will consist of only two outcomes. Finally, the third would be made up of two outcomes, namely, "I read biology textbooks/hand-outs and make my own notes" and "enough time is allocated on the school time table for the teaching and learning of biology". They are the outcomes that have to do with time for individual studies and that of classroom teaching and learning.

Table 18: Latent Factors for Indicators of Classroom Activities

	Component			
	1	**2**	**3**	**Extraction**
The teacher allows me to handle materials and equipment during practical lessons	**.740**	-.127	-.021	.565
The teacher involves me in practical activities	**.680**	.128	-.052	.481
The teacher makes use of sufficient resources (pictures, tables, animations, computers etc.)	**.648**	-.117	-.186	.468
I work in groups with other classmates	**.575**	.226	.375	.522
I hold discussions with others on the various topics	**.455**	.231	.616	.640
I am allowed to ask questions to aid my understanding of concepts	**.450**	.339	.035	.319
The teacher uses various tools (quizzes, exercise, assignment, projects etc.) to assess my work	.079	**.710**	-.198	.550
The teacher marks my quizzes and class exercises on time and gives me feedback accordingly	.166	**.714**	-.104	.548
I copy the notes that the teacher dictates/writes on the board	-.116	**.511**	.067	.279
I read biology textbooks/hand outs and make my own notes	-.028	-.334	**.559**	.425
Enough time is allocated on the school time table for the teaching and learning of biology	.290	.107	**-.560**	.409

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 9 iterations.

From Table 19, 99 (93.4%) of the respondents agreed that they had a good understanding of biology with an agreement mean level of 4.31 and standard deviation of 0.85. Also, 86 (81.13%) of the respondents agreed that during lesson delivery they introduced activities that promoted mutual learning among students as well as encouraging students to initiate collaborative inquiry-based learning with a mean agreement of 3.89 and standard deviation of 0.99. Again, 82 (77.36%) of the respondents agreed that there were some challenges in relation to their teaching functions. This also recorded a mean level of agreement of 3.87 with a standard deviation of 1.05. However, 77 (72.64%) of the respondents agreed that the school‟s curriculum is crowded with an agreement mean level of 4.09 and standard deviation of 1.12.

Table 19: Opinions of Teachers on the Implementation of the Biology Curriculum

	N Agreement	% Agreement	Mean	Standard Deviation
Does your school have adequate equipment, facilities, laboratories and general resources required for implementation of the biology programme?	65	61.32	3.17	1.27
There are some challenges in the course of teaching functions	82	77.36	3.87	1.05
There is enough support for teachers from within the school and outside, e.g. opportunities to receive ongoing curriculum professional support.	35	33.02	2.60	1.28
There is enough time available for preparing and delivering the requirements of the biology course, e.g. enough time to develop your own understanding of the subject you are required to teach	63	59.43	3.23	1.19
Have you ready access to science materials and resources in this school to enable you implement the biology programme as demanded by the objectives of the curriculum?	51	48.11	3.17	1.18
Is the school curriculum crowded? Does biology suffer because of this?	77	72.64	4.09	1.12
During lesson delivery do you introduce activities that promote mutual learning among students as well as encourage students to initiate collaborative inquiry-based learning?	86	81.13	3.89	0.99
Does the biology programme enable students to acquire the relevant manipulative skills that enable them to handle and operate science equipment and materials effectively at the end of the lessons?	42	39.62	2.94	1.09
You have a good understanding of biology. i.e. knowledge, skills and attitude needed to promote in teaching of SHS biology.	99	93.40	4.31	0.85
Do you have the opportunity to undertake professional development in biology to enhance your role in teaching biology?	53	50.00	3.10	1.20

Table 20 contain the results of the observation of teachers in terms of verbal activities. For activities "asks question requiring recall of previous learning", "ask questions requiring students" ideas", answering student"s questions", answers own questions", "explains meaning of words", "comments on students work or answers", "asks pupils to comment on each other"s answer", "gives information" and "gives instruction", all the schools performed such activities throughout the lesson. For "ask for report/description of work" and "asks questions for supervision/control (not topic)", Grade A schools performed such activity throughout the lesson, Grade B performed such an activity but not throughout the lesson, but Grade C school did not perform such an activity throughout the lesson. For the activity "refers to worksheet", none of the schools performed such activity.

Table 20: Observations of Teachers in Terms of Verbal Activities

Activity	Grade of School	Average Number of Times for Activity:				
		1 - 10 mins	11 - 20 mins	21 - 30 mins	31 - 40 mins	41 - 50 mins
Asks question requiring recall of previous learning	A	1.40	1.20	0.60	0.20	0.00
	B	3.00	0.75	1.00	0.00	0.75
	C	1.50	0.50	1.00	0.50	0.50
	Total	**1.92**	**0.85**	**0.85**	**0.23**	**0.38**
Asks questions requiring students ideas	A	3.60	2.00	1.00	0.00	0.20
	B	2.50	3.50	0.50	0.25	0.50
	C	8.50	7.00	4.75	1.25	0.25
	Total	**4.77**	**4.00**	**2.00**	**0.46**	**0.31**
Asks for report/description of work	A	0.40	0.40	0.20	0.20	0.00
	B	1.00	0.25	0.00	0.00	0.50
	C	0.00	0.00	0.00	0.00	0.00
	Total	**0.46**	**0.23**	**0.08**	**0.08**	**0.15**
Asks questions for supervision/control (not topic)	A	2.60	0.20	0.80	0.20	0.00
	B	0.75	0.75	0.00	0.00	0.25
	C	0.00	0.00	0.00	0.00	0.00
	Total	**1.23**	**0.31**	**0.31**	**0.08**	**0.08**
Answering student"s questions	A	0.40	0.60	1.80	1.00	0.00
	B	0.25	0.25	0.50	2.00	0.50
	C	0.25	0.75	0.25	0.75	0.50
	Total	**0.31**	**0.54**	**0.92**	**1.23**	**0.31**
Answers own questions	A	1.40	0.20	1.00	0.60	0.00
	B	1.25	1.00	1.50	0.25	0.75
	C	1.00	0.25	0.00	0.25	0.00
	Total	**1.23**	**0.46**	**0.85**	**0.38**	**0.23**
Explains meaning of words	A	2.40	5.60	4.40	2.40	1.80
	B	4.00	6.50	5.00	1.75	1.50
	C	8.75	13.75	11.50	12.00	8.25
	Total	**4.85**	**8.38**	**6.77**	**5.15**	**3.69**
Comments on students work or answers	A	1.80	2.00	2.40	1.40	1.20
	B	2.75	2.50	2.25	3.25	0.50
	C	4.00	5.25	4.00	0.75	0.00
	Total	**2.77**	**3.15**	**2.85**	**1.77**	**0.62**
Asks pupils to comment on each other"s answer	A	0.40	0.40	0.80	0.40	0.00
	B	0.00	0.25	0.00	0.00	3.25
	C	0.75	0.25	3.50	0.00	0.00
	Total	**0.38**	**0.31**	**1.38**	**0.15**	**1.00**
Gives information	A	8.00	5.60	5.60	3.00	1.60
	B	6.50	7.25	4.25	1.75	1.00
	C	12.75	13.50	12.00	12.25	9.00
	Total	**9.00**	**8.54**	**7.15**	**5.46**	**3.69**
Gives instruction	A	1.80	1.60	0.40	0.40	0.00
	B	0.75	0.00	0.50	0.25	0.00
	C	2.50	5.00	2.25	0.75	1.25
	Total	**1.69**	**2.15**	**1.00**	**0.46**	**0.38**
Refers to worksheet	A	0.00	0.00	0.00	0.00	0.00
	B	0.00	0.00	0.00	0.00	0.00
	C	0.00	0.00	0.00	0.00	0.00
	Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Other	A	0.00	0.00	0.00	0.00	0.00
	B	0.50	0.50	1.75	1.50	0.25
	C	0.00	0.25	0.00	0.00	0.00
	Total	**0.15**	**0.23**	**0.54**	**0.46**	**0.08**

Data presented in Table 21 were on observation of teachers in terms of non-verbal activities. For "uses black board to record student findings/ideas", "uses black board for other purpose", "demonstrate activity/what to do", "listens to students" and "observe students/not interacting", all the schools performed such activities throughout the lesson. For "helps with use of specific equipment (not activity)", Grade A and B schools performed such activities but not throughout the lesson, but none of the Grade C school performed such activity. For "organises/distributes equipment", none of the schools performed such activity.

Table 21: Observation of Teachers in Terms of Non-Verbal Activities

Activity	Grade of School	Average Number of Times for Activity:				
		1 - 10 mins	11 - 20 mins	21 - 30 mins	31 - 40 mins	41 - 50 mins
Uses black board to record students" findings/ideas	A	5.60	2.00	3.40	1.00	0.60
	B	4.25	2.00	1.25	0.00	0.00
	C	1.75	0.50	1.50	0.00	0.00
	Total	**4.00**	**1.54**	**2.15**	**0.38**	**0.23**
Uses black board for other purpose	A	3.40	0.60	3.20	1.00	0.60
	B	3.50	3.00	1.50	0.00	0.00
	C	6.00	5.75	4.00	3.50	0.75
	Total	**4.23**	**2.92**	**2.92**	**1.46**	**0.46**
Organises/distributes equipment	A	0.00	0.00	0.00	0.00	0.00
	B	0.00	0.00	0.00	0.00	0.00
	C	0.00	0.00	0.00	0.00	0.00
	Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Demonstrate activity/what to do	A	1.00	0.80	0.80	1.00	0.60
	B	1.25	0.75	0.25	0.50	0.00
	C	0.50	0.50	1.50	0.50	0.75
	Total	**0.92**	**0.69**	**0.85**	**0.69**	**0.46**
Helps with use of specific equipment (not activity)	A	0.00	0.20	0.00	0.40	0.00
	B	0.25	0.00	0.75	0.00	0.00
	C	0.00	0.00	0.00	0.00	0.00
	Total	**0.08**	**0.08**	**0.23**	**0.15**	**0.00**
Listens to students	A	3.00	2.60	4.00	2.00	3.60
	B	0.50	1.50	1.00	0.25	0.00
	C	2.50	3.50	1.75	0.50	0.25
	Total	**2.08**	**2.54**	**2.38**	**1.00**	**1.46**
Observe students/not interacting	A	3.60	2.00	2.00	0.00	0.00
	B	1.50	1.75	1.50	1.00	0.00
	C	5.00	5.00	5.00	4.00	3.00
	Total	**3.38**	**2.85**	**2.77**	**1.54**	**0.92**
Other	A	4.80	5.00	4.80	1.80	1.00
	B	5.00	5.00	5.00	3.75	0.75
	C	2.50	2.50	2.50	1.50	0.75
	Total	**4.15**	**4.23**	**4.15**	**2.31**	**0.85**

Observation using the modified version of the Barbados workshop instrument

This part of the analysis dealt with observations made using the modified version of the Barbados Workshop Instrument adapted by Eminah (2007), for data collection. A teacher from Grade A School who was teaching the topic Cell division was observed. However, major movement of the teacher in the class was in front of the class where he or she spent more than two minutes per stoppage throughout the lesson. Minor movements were in the middle of the class with only one movement at the back. For the observation of group analysis relating to task, only "raising of questions" activity was observed throughout the lesson. The rest of the activities in this category were not observed. Moreover, in the tasks relating to the teacher, all of the activities were observed throughout the lesson. On the other hand, activities relating to each other, "listening/responding to other ideas" was observed throughout the lesson, also "talk about the topic/task" and "independent working" were observed around 17^{th} to 20^{th} minute of the lesson. Finally, for the observation of the teacher in terms of verbal and non-verbal activities, almost all of them were observed throughout the lesson.

One of the teachers from a Grade B School who was teaching the topic Domestic Fowl was also observed. However, major movements of the teacher in the class were in front of the class where he spent between two and four minutes per stoppage with some less than two minutes throughout the lesson. Minor movements were in the middle of the class with none of movement at the back. For the observation of group analysis relating to task, none of them was observed throughout the lesson. Moreover, the one relating to the teacher, all of them were observed throughout the lesson except "asking for help about procedure". On the other hand, the one relating to each other, "listening/responding to other ideas" was observed almost throughout the lesson, as "talk about the topic/task" and "non-topic/task talk" were observed around 11th to 12th minute of the lesson hours. For the observation of teacher in terms of verbal, all of them were observed at some part of the lesson period except "ask questions for supervision/control (not topic)", "asks pupils to comment on each other"s answers", "gives instruction" and "refers to worksheet" were not observed. On the other hand, for non-verbal activities, almost all of them were observed throughout the lesson.

A teacher from a Grade C School who was teaching Protein Synthesis was also observed. All the movements of the teacher in the class was in front of the class where he spent between two and four minutes per stoppage with some less than two minutes throughout the lesson. None of movements were in the middle as well as at the back. For the observation of group analysis relating to task, none of the activities was observed throughout the lesson. Moreover, in the task relating to the teacher, all of the activities were observed throughout the lesson except the activity "asking for help about procedure". On the other hand, in the task relating to each other, "listening/responding to other ideas" was observed at the early part of the lesson, as none of the rest of the activities was observed. For the observation of teacher in terms of verbal activities, all of the activities in this category were observed at some part of the lesson except "ask questions for supervision/control (not topic)" and "asks for report/description of work" were not observed. On the other hand, for non-verbal activities, almost all of the activities were observed throughout the lesson except "organizes/distributes equipment" and "helps with use of specific equipment (not activity)" were not observed.

Research Question 4: Which aspects of the biology lessons are in agreement with the Senior High School biology curriculum prescriptions?

The aim of this research question was to establish how biology teachers" instruction was carried out in selected Senior High Schools in the Central Region. It sought to find out the methods of instruction mostly adopted by teachers during practical and theory lessons and the factors that accounted for the choice of particular instructional method. In answering this particular research question consideration were given to factors such as class size, presence and role of laboratory technicians/assistants, the state of the laboratory among other pertinent issues raised.

Table 22 examine the suggestions of the biology curriculum for Senior High Schools. From the Table, it could be deduced that the entire seven (7) Grade A schools visited had botanical gardens, six (6) had animals in cages for biology practical, three (3) had fish ponds and all seven schools did not have insects in a cage. With regards to visits to the seven suggested places of academic importance by the curriculum schools"; the first school had three (3) of such visits, the second school had four (4), the third school had three (3), the fourth school had one (1), the fifth school had three (3), the sixth school had four (4) and the seventh school had two (2) of such visits.

With regards to Grade B schools two schools out of the seven (7) had botanical gardens, three (3) had animals in a cage and only one (1) school had a fishpond. With regards to planned visits to the seven suggested places of academic importance by the curriculum only two schools performed such an activity once to an Agricultural Research Institute and the seashore respectively.

Grade C schools visited did not have botanical gardens, animals in a cage, fish pond or insects in a cage. More to that, places of academic significance to be visited was executed by only one (1) school, which was to a well-established experimental and commercial farm. The rest of the schools did not organise any of such visits as suggested by the biology curriculum.

Table 22: Biology Curriculum Facilities and Prescriptions for Schools

	Available Facilities				**Plan visits to:**							
Category of Schools Visited	Small botanical Garden	Animals In a Cage	Fishpond	Insects in a Cage	Well established Experimental and Commercial Farms	Agricultura l Research Institutes	Scientific and Manufacturing Organisations	Forest and Game Reserves	Man-made Lakes	Seashore	Hospitals	Total
A												
1	Yes	Yes	No	No	No	Yes	No	Yes	No	Yes	No	**5**
2	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	No	**7**
3	Yes	No	No	No	Yes	Yes	No	No	No	Yes	No	**4**
4	Yes	Yes	No	No	No	No	No	No	No	Yes	No	**3**
5	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No	No	No	**6**
6	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No	Yes	No	**7**
7	Yes	Yes	No	No	No	No	Yes	No	No	Yes	No	**4**
B												
1	No	No	No	No	No	No	No	No	No	No	No	**0**
2	Yes	No	Yes	No	No	No	No	No	No	No	No	**2**
3	No	No	No	No	No	No	No	No	No	No	No	**0**
4	Yes	No	No	No	No	No	No	No	No	No	No	**1**
5	No	No	No	No	No	No	No	No	No	No	No	**0**
6	No	Yes	No	No	No	No	No	No	No	No	No	**1**
7	No	Yes	No	No	No	No	No	No	No	Yes	No	**2**
C												
1	No	No	No	No	Yes	No	No	No	No	No	No	**1**
2	No	No	No	No	No	No	No	No	No	No	No	**0**
3	No	No	No	No	No	No	No	No	No	No	No	**0**
4	No	No	No	No	No	No	No	No	No	No	No	**0**
5	No	No	No	No	No	No	No	No	No	No	No	**0**
6	No	No	No	No	No	No	No	No	No	No	No	**0**
7	No	No	No	No	No	No	No	No	No	No	No	**0**
Total	**9**	**8**	**4**	**0**	**5**	**5**	**3**	**2**	**0**	**7**	**0**	**53**

Table 23 further examines how accessible the biology syllabus was to the teachers. There was an indication that 62 respondents representing 58.1% had a copy of the syllabus. Also, 30 out of the total of 106 teacher respondents representing 29.0% used the GAST textbook in place of the syllabus whilst 14 respondents representing 12.9% always had a copy of the syllabus for reference. None of the respondents stated that they do not teach without reference to the syllabus. Moreover, 62 respondents out of the total of 106 representing 58.1% stated that the content of the biology curriculum available to the teachers were partially in line with the recommended textbooks, followed by 41 respondents, representing 38.7%, indicating that the contents were completely in line with the recommended textbooks. Only 3 respondents representing 3.2% indicated that the contents of the biology syllabus were not in line with the available recommended textbooks.

Table 23 also examined how students take notes in class. Sixty (60) respondents representing 56.6% took notes as the teacher dictates followed by 24 respondents representing 22.6% took notes during the lesson. Eleven (11) respondents representing 10.4% copied notes verbatim from their colleagues during the lesson whilst another 11 respondents representing 10.4% made their own notes from textbooks.

Table 23: Biology Curriculum Activity Prescriptions

		Male		Female		Total	
		Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**
What are the textbooks available for teaching and learning biology?	Modern Biology	3	5.0	4	9.1	7	6.5
	Functional Approach	0	0.0	4	9.1	3	3.2
	Biology For SHS (GAST)	65	95.0	30	81.8	96	90.3
	Other (Specify)	0	0.0	0	0.0	0	0.0
Do you have a current syllabus for use in your school?	Yes	61	90.0	24	63.6	85	80.6
	No	7	10.0	14	36.4	21	19.4
How accessible is the biology syllabus to you?	I Have A Copy Myself	41	60.0	21	54.5	62	58.1
	A Copy Is Always Available For Reference	3	5.0	10	27.3	14	12.9
	I Use The GAST Textbook In Place Of The Syllabus	24	35.0	7	18.2	30	29.0
	I Teach Without Reference To The Syllabus	0	0.0	0	0.0	0	0.0
Are the contents of the biology syllabus available to you in line with the recommended textbooks?	Not In Line	3	5.0	0	0.0	3	3.2
	Partially In Line	41	60.0	21	54.5	62	58.1
	Completely In Line	24	35.0	17	45.5	41	38.7
How do students take notes in class?	Teacher dictates notes	41	60.9	19	50.0	60	56.6
	Students make their own notes from textbooks	7	10.9	4	9.5	11	10.4
	Students take notes during the lesson	7	10.9	15	40.5	24	22.6
	Other	11	17.2	0	0.0	11	10.4
At the end of each lesson	Yes	34	50.0	21	54.5	55	51.6
	No	34	50.0	17	45.5	51	48.4
At the end of teaching each topic	Yes	37	55.0	31	81.8	68	64.5
	No	31	45.0	7	18.2	38	35.5
During organised term quizzes	Yes	24	35.0	14	36.4	38	35.5
	No	44	65.0	24	63.6	68	64.5
Before the start of end of term examination	Yes	7	10.0	4	9.1	10	9.7
	No	61	90.0	34	90.9	96	90.3
End of term examination	Yes	14	20.0	17	45.5	31	29.0
	No	54	80.0	21	54.5	75	71.0
In your opinion, do you think the Senior High School biology programme is a good initiative and should be allowed to stay?	Yes	64	95.0	34	90.9	99	93.5
	No	4	5.0	4	9.1	7	6.5
Total		**68**	**100.0**	**38**	**100.0**	**106**	**100.0**

The respondents were asked whether the SHS biology programme should be allowed to continue and were also to mention two areas they thought required improvement or innovation and how they wished it should be done. Their responses, were transcribed as follows: "*Activities on key topics should be made more practical and applicable in everyday situation and content of some key topics should be revised, so that the two and half years will be appropriate to cover the syllabus. Another respondent added that adequate provision of TLMs, laboratory equipment, laboratory technicians, WAEC syllabus and better biology textbooks. Again, a respondent explained that some biology classifications, for example specimens, are learnt in abstract without seeing the real organisms. GES should release funds to undertake field trips and provide dummy organisms for theory and practical lessons e.g. in genetics and evolution. Also, videos can be provided to schools in line with the curriculum prescriptions to give more meaning since biology is so abstract, adding that the concept needs to embrace comparative embryology since we evolve from one species to another. Again, one respondent added that hands-on activities i.e. how to use some equipment for teaching and integration of more technology into teaching biology on the part of teachers and lab technicians need to be encouraged. Also, there should be improvement in teaching and learning resources, introduction to ICT in lesson delivery and stakeholders and NGOs should assist to stock the biology labs with modern teaching resources. Learning resources should be brought to schools to make teaching and learning more practical and students should be given the opportunity to spend exactly three years at school so that the curriculum can be completed before they write WASSCE. More periods should be allocated to biology to allow a lot of hands on activities and enough TLMs should be made available to schools. Practical experiments should be streamlined in such a way that they will be* *in the form of project or assignment for students to undertake under supervision of the teacher. Provision of practical materials and supply enough textbooks to students. The number of years for the Senior High School programme should be four years to give enough time for the completion of the topics. With regards to the practical aspect, schools with laboratories should be well equipped to enhance teaching and learning. Both GES and WAEC should have the same curriculum for Senior High School biology. There should be a GAST teachers' handbook on biology practical and regular in-service training for biology teachers. There should be comprehensive videos on all topics and made available to all biology teachers and laboratory equipment and specimen should be adequate to enhance effective teaching and learning.*

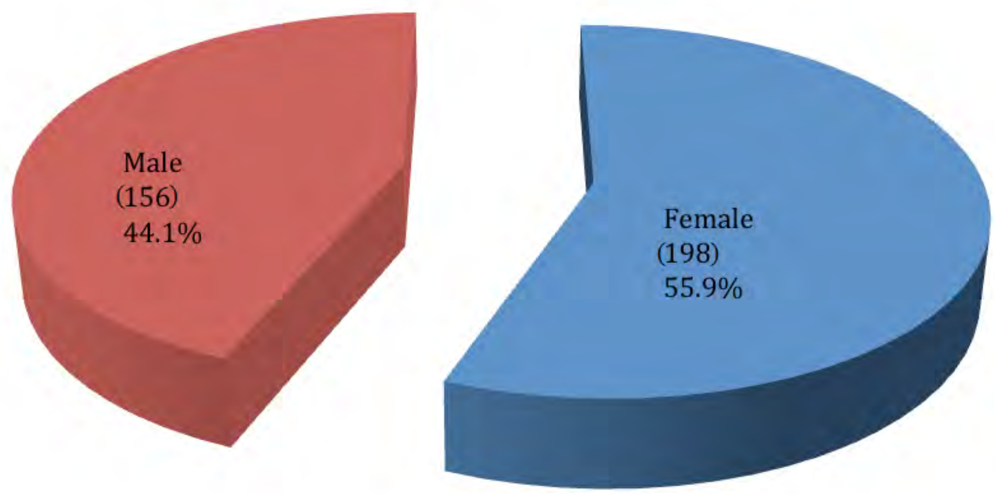

Figure 10: Sex of the students

Figure 10 show the gender distribution of the students. Out of the total sample of 354 respondents, 198 representing 55.9% were made up of female respondents and 156 representing 44.1% were males. This clearly indicates that females dominated the student respondents.

From Table 24, it could be seen that 335 respondents out of the total respondents of 354 representing 94.7% described the type of interaction in their classroom as mostly teacher-student centred. Also, 12 respondents representing 3.5% described the type of interaction in their classroom as mostly student-student centred whiles 7 respondents representing 1.8% described the type of interaction in their classroom as mostly student-resources centred. However, none of the respondents indicated that the interaction in their classroom was mostly teacher- resources centred.

Table 24: Type of Interaction in Biology Classrooms

Classroom Interactions	Male		Female		Total	
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**
Teacher-student centred	146	93.3	189	95.8	335	94.7
Student-student centred	6	4.0	6	3.2	12	3.5
Teacher-resources centred	0	0.0	0	0.0	0	0.0
Student-resources centred	4	2.7	3	1.1	7	1.8
Total	**156**	**100.0**	**198**	**100.0**	**354**	**100.0**

Research Question 5: Which aspects of the profile dimensions specified in the biology curriculum do the students exhibit during practical activities?

This research question sought to determine the knowledge and process skills exhibited by the students during practical lessons as suggested by the curriculum designers. Data presented in Table 25 were on observation of group relating to task. For "making observations", it can be seen that only grade A schools" performed such an activity in the middle of the lesson. None of the Grade B and C schools performed such activity. In the "raising of questions", Grade A schools performed such activity throughout the lesson, as grade B schools performed it during the middle of the lesson. None of the Grade C School performed such activity. However, none of the schools performed "suggesting hypothesis", predicting, "findingpattern/relationship", "devising and planning investigations", "handling material/ equipment" and "measuring/ calculating and recording".

Table 25: Observation of Groups Relating to Task

Activity	Grade of School	Average Number of Times for Activity:				
		1 - 10 mins	11 - 20 mins	21 - 30 mins	31 - 40 mins	41 - 50 mins
Making observations	A	0.00	0.00	1.00	0.20	0.00
	B	0.00	0.00	0.00	0.00	0.00
	C	0.00	0.00	0.00	0.00	0.00
	Total	**0.00**	**0.00**	**0.38**	**0.08**	**0.00**
Raising questions	A	0.40	1.00	3.80	2.40	1.40
	B	0.00	0.00	0.25	0.00	0.00
	C	0.00	0.00	0.00	0.00	0.00
	Total	**0.15**	**0.38**	**1.54**	**0.92**	**0.54**
Suggesting hypothesis	A	0.00	0.00	0.00	0.00	0.00
	B	0.00	0.00	0.00	0.00	0.00
	C	0.00	0.00	0.00	0.00	0.00
	Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Predicting	A	0.00	0.00	0.00	0.00	0.00
	B	0.00	0.00	0.00	0.00	0.00
	C	0.00	0.00	0.00	0.00	0.00
	Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Finding pattern/relationship	A	0.00	0.00	0.00	0.00	0.00
	B	0.00	0.00	0.00	0.00	0.00
	C	0.00	0.00	0.00	0.00	0.00
	Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Devising and planning investigations	A	0.00	0.00	0.00	0.00	0.00
	B	0.00	0.00	0.00	0.00	0.00
	C	0.00	0.00	0.00	0.00	0.00
	Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Handling material/equipment	A	0.00	0.00	0.00	0.00	0.00
	B	0.00	0.00	0.00	0.00	0.00
	C	0.00	0.00	0.00	0.00	0.00
	Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Measuring/calculating	A	0.00	0.00	0.00	0.00	0.20
	B	0.00	0.00	0.00	0.00	0.00
	C	0.00	0.00	0.00	0.00	0.00
	Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.08**
Recording	A	0.00	0.00	0.00	0.00	0.00
	B	0.00	0.00	0.00	0.00	0.00
	C	0.00	0.00	0.00	0.00	0.00
	Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Other	A	0.40	0.00	0.00	0.00	0.00
	B	0.25	0.33	0.00	0.75	0.00
	C	0.00	0.00	0.00	0.00	0.00
	Total	**0.23**	**0.08**	**0.00**	**0.23**	**0.00**

Table 26 also present results on observation of group relating to teacher. For "asking about the topic", "answering teachers question in terms of fact and recall", "answering teachers question in terms of ideas", "reporting/explaining actions" and "listening to teacher", all the schools experienced such activities throughout the lesson. On the contrary, Grade A and B schools experienced "asking for help about procedure" throughout the lesson, but none of the Grade C schools experienced such activity.

Table 26: Observation of Student Work Groups Relating to Teacher

Activity	Grade of School	Average Number of Times for Activity:				
		1 - 10 mins	11 - 20 mins	21 - 30 mins	31 - 40 mins	41 - 50 mins
Asking about topic	A	.80	2.00	5.00	2.20	1.40
	B	.00	.25	.25	.25	.00
	C	.50	.50	1.00	1.00	.50
	Total	**.46**	**1.00**	**2.31**	**1.23**	**.69**
Asking for help about procedure	A	.40	.40	.20	.40	.00
	B	1.50	.75	.75	.25	.00
	C	.00	.00	.00	.00	.00
	Total	**.62**	**.38**	**.31**	**.23**	**.00**
Answering teachers question (Fact/Recall)	A	9.20	6.60	7.20	3.60	.80
	B	7.50	4.50	1.50	.50	1.00
	C	12.50	9.25	9.00	3.00	1.75
	Total	**9.69**	**6.77**	**6.00**	**2.46**	**1.15**
Answering teachers question (Ideas)	A	9.00	6.60	7.20	3.40	.80
	B	6.00	3.75	1.50	.50	.50
	C	12.00	9.25	9.00	3.00	1.75
	Total	**9.00**	**6.54**	**6.00**	**2.38**	**1.00**
Reporting/explaining actions	A	6.80	4.40	4.40	3.80	2.40
	B	2.75	3.75	2.50	.25	.00
	C	8.25	7.25	6.75	1.50	.00
	Total	**6.00**	**5.08**	**4.54**	**2.00**	**.92**
Listening to teacher	A	6.00	4.00	3.00	1.00	1.00
	B	3.75	3.75	3.75	2.50	.75
	C	5.00	5.00	5.00	4.25	3.75
	Total	**5.00**	**4.23**	**3.85**	**2.46**	**1.77**
Other	A	.00	.00	.00	.00	.00
	B	.00	.00	.00	.00	.00
	C	.00	.00	.00	.00	.00
	Total	**.00**	**.00**	**.00**	**.00**	**.00**

In Table 27, results are presented on observation of group relating to each other. For "organising task in terms of co-operatively" and "talk about record/report", none of the schools performed such activity. For "organising task in terms of argument" and "non-topic/task talk", only Grade B school performed such activity between the 11th and 20th minutes of the lesson. For "talk about topic/task", only Grade A school performed such an activity between the 11th and 30th minutes of the lesson. For "listening responding to others ideas", all the schools performed such activity. For "independent working", all the schools performed such an activity but not throughout the lesson. For numbers activity/purposefully working", only Grade A performed such an activity throughout the lesson.

Table 27: Observation of Student Work Groups Relating to each Other

Activity	Grade of School	Average Number of Times for Activity:				
		1 - 10 mins	11 - 20 mins	21 - 30 mins	31 - 40 mins	41 - 50 mins
Organising task (co-operatively)	A	0.00	0.00	0.00	0.00	0.00
	B	0.00	0.00	0.00	0.00	0.00
	C	0.00	0.00	0.00	0.00	0.00
	Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Organising task (argument)	A	0.00	0.00	0.00	0.00	0.00
	B	0.00	0.25	0.00	0.00	0.00
	C	0.00	0.00	0.00	0.00	0.00
	Total	**0.00**	**0.08**	**0.00**	**0.00**	**0.00**
Talk about topic/task	A	0.80	0.80	0.60	0.00	0.00
	B	0.00	0.00	0.00	0.00	0.00
	C	0.00	0.00	0.00	0.00	0.00
	Total	**0.31**	**0.31**	**0.23**	**0.00**	**0.00**
Talk about record/report	A	0.00	0.00	0.00	0.00	0.00
	B	0.00	0.00	0.00	0.00	0.00
	C	0.00	0.00	0.00	0.00	0.00
	Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Non-topic/task talk	A	0.00	0.00	0.00	0.00	0.00
	B	0.00	0.25	0.00	0.00	0.00
	C	0.00	0.00	0.00	0.00	0.00
	Total	**0.00**	**0.08**	**0.00**	**0.00**	**0.00**
Listening /responding to others ideas	A	3.80	4.60	4.40	2.40	1.60
	B	4.25	4.25	3.75	3.25	0.75
	C	4.25	3.50	2.50	3.00	1.75
	Total	**4.08**	**4.15**	**3.62**	**2.85**	**1.38**
Independent working	A	0.60	0.80	0.00	0.20	0.20
	B	1.25	0.00	0.00	0.00	0.00
	C	0.00	0.00	0.00	0.25	1.25
	Total	**0.62**	**0.31**	**0.00**	**0.15**	**0.46**
Numbers actively/ purposefully working	A	0.40	0.60	1.00	0.60	0.20
	B	0.00	0.00	0.00	0.00	0.00
	C	0.00	0.00	0.00	0.00	0.00
	Total	**0.15**	**0.23**	**0.38**	**0.23**	**0.08**
Other	A	0.80	0.00	0.20	0.00	0.00
	B	0.00	0.00	0.00	0.00	0.00
	C	1.25	1.25	1.25	0.50	0.00
	Total	**0.69**	**0.38**	**0.46**	**0.15**	**0.00**

Research Question 6: What support services and capacity enhancing activities are organised for the biology teachers in the selected Senior High Schools?

Table 28 shows data of biology teachers who had received in-service training. It is evident from the results that the majority (61.3%) of the teachers had undergone in-service training whilst 38.7% of the teachers said they had not received any in-service training in biology.

Table 28: Frequency of Biology Teachers who had Received In-service Training

Responses	Frequency	Percentage (%)
Yes	65	61.3
No	41	38.7
Total	**106**	**100**

Table 29 showed that, the main organiser of in-service training was GAST. GAST accounted for 50.1% of the total number of in-service programmes attended by the respondents. The next leading organiser was the STMIE which also accounted for17.9 % of the in-service training programmes.

Table 29: Organisers of In-service Training Programmes

Responses	Frequency	Percentage
GAST	53	50.1
GES	19	17.9
STMIE	24	22.6
Any Other	10	9.4
Total	**106**	**100**

Table 30 sought to find out how regularly biology teachers attended in-service training programmes. Teachers felt that in-service training programmes were not organised frequently. Approximately 73% of the respondents attended in-service programmes once a while as displayed in Table 28.

Table 30: Frequency of In-service Training and Workshops

Responses	Frequency	Percentage (%)
Very often	9	8.5
Quite often	20	18.9
Once in a while	77	72.6
Total	**106**	**100**

CHAPTER FIVE

DISCUSSION

5.0 Overview

This chapter discusses thoroughly the summary of the results of the study. The research objectives are also discussed under themes in this chapter, such that each theme is related to a research objective/question.

5.1 The Educational Qualifications of the Biology Teachers in the selected Senior High Schools

Teaching is the main way of promoting learning and achievement among students but teaching and learning are what affect knowledge, skills, attitudes, and the capacity of young people to contribute to contemporary societies (Mangal, 2007).

Table 4 clearly show that out of the 106 respondents, 7 (6.6%) possessed an M.Phil. degree in Grade A schools, which were in Aquaculture and Zoology. Four (3.7%) of M.Phil. holders could also be found in Grade B Schools" whilst none was located in Grade C schools. On the other hand, 8 (7.6%) possessed an M. Ed. degree in Grade A schools whilst 4 (3.7%) were found in Grade B schools. None was recorded in this category for Grade C schools.

It has long been recognized that teachers have a major role in determining and implementing the curriculum. They interpret and give life to the curriculum specifications of governments and ministries, and translate curriculum intentions into classroom practices (Norris, 1998). As Scott (1994) mentions, they not only control the rate but also the degree of change of any curriculum.

Furthermore, 24 (22.65%) of the respondents possessed B.Ed. degree(s) in Science specializing in biology in Grade A schools, 7 (6.60%) were in Grade B schools whilst 10 (9.43%) were also in Grade C schools. Four (3.7%) of B.Sc. with PGDE (Post Graduate Diploma in Education) were in Grade A schools, 4 (3.7%) were also in Grade B schools whilst none was recorded in Grade C schools. In another instance, 24 (22.65%) of B.Sc. holders were in Grade B schools, 10 (9.43%) were also in Grade C schools whilst none were recorded in Grade A schools.

From Table 4, it was also clear that in Grade A schools most of the teachers were academically and professionally qualified to implement the Senior High School biology curriculum. These statistics are backed with figures represented on the table as follows; 7 (6.60%) M.Phil. holders, 8 (7.56%) M. Ed. holders, 24 (22.65%) B.Ed. and 4 (3.7%) in B.Sc. with PGDE holders.

Hawthorne (1992) also emphasized that the curriculum enacted in each classroom results largely from the individual teacher‟s preferences, professional understandings, and perceptions of student needs and interests.

Also, 4 (3.7%) of teachers in Grade B schools possessed an M.Phil. or M. Ed. in Science Education, which makes them academically and professionally qualified to implement the biology curriculum. Seven (6.60%) of the respondents were B.Ed. Science holders, specializing in biology whilst 4 (3.7%) possessed B.Sc. but have gone further to acquire a PGDE to augment their professional status. A significant number, 24 (22.65%), of the respondents possessed B.Sc. in various fields such as Agriculture, Animal Husbandry, Environmental Science, Integrated Science, Molecular Biology and Biotechnology just to mention, but a few, were also teaching biology in Senior High Schools due to lack of academically and professionally qualified teachers in that regard. From the results it was revealed that the WAEC Chief examiner for biology in the Central Region of Ghana possessed a second degree in Fisheries and Aquaculture and not in biology. This shows that, there are teacher shortages in biology at the Senior High School level.

Finally, in Grade C schools, 10 (9.43%) of the total respondents possessed B.Ed. in Science specializing in Biology and 10 (9.43%) also possess B.Sc. in various Sciences which made such individuals academically qualified but professionally not qualified to implement the Senior High School biology curriculum. With regards to higher degrees such as M.Phil. or M.Ed. none was recorded in Grade C schools, finally B.Sc. with PGDE also recorded 0%.

From the results gathered, professionally and academically qualified teachers should be equally distributed to all the categories (A, B and C) of Senior High Schools, so that they would not be concentrated in the Grades A and B schools. When this is done, students in the various categories of schools would all receive a fair education in the biology programme. It would also ensure that there is no rush for Grade A, or B category of schools during the Computerised School Selection Programme Software (CSSPS) placement processes. On the biology teachers‟ areas of specialization, it was found that some of the teachers specialised in such fields as Agriculture, Animal Husbandry, Environmental Science, Integrated Science, Molecular Biology and Biotechnology. This was perhaps one of the remote causes of the teachers‟ poor performance with regards to methodology and organisation of practical activities.

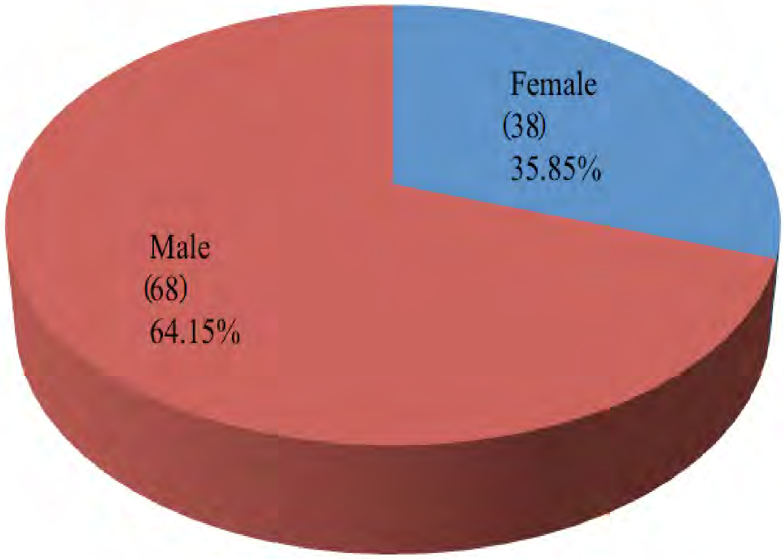

Figure 7: The Sex of Teacher Respondents

Figure 7 shows the distribution of the teacher respondents by sex. Out of the total sample of 106 respondents, 68 representing 64.15% were male respondents and 38 representing 35.85% were females. This clearly indicates that the respondents were male dominated. More female teachers in biology must be trained to handle girls and act as role models in that regard.

Table 5 also examined the number of years the respondents taught Senior High School biology. There was an indication that the females recorded a mean of 6.45 with a standard deviation of 3.11, whereas the males recorded a mean of 7.40 with a standard deviation of 6.68. Again, the Table (5) further examined the number of years teaching Senior High School biology by the type of school of which there was an indication that Grade C type of school recorded a mean of 4.17 with a standard deviation of 1.83 whereas, Grades A and B school types recorded a mean of 6.79 with a standard deviation of 4.00, and a mean of 9.00 with a standard deviation of 7.95 respectively.

Effahs"s (2014) findings also showed that years of teaching experience affected teachers" views on the values of the curriculum. They therefore demonstrated different meanings of fidelity of implementation in their everyday classroom situations. Similarly, Cho (2001) reported that the novice teacher in the study faithfully used the new curriculum materials based primarily upon the intent of the curriculum developer. What worked best for students‟ learning in their classrooms was guaranteeing the right things covered at right times and in an organized manner. This was because the teacher felt the need to learn new skills and build on content knowledge for teaching. In contrast, the experienced teacher considered the new curriculum materials to be teaching tools and adaptively used the ideas of the curriculum developer. Also, such teachers would be using out-dated knowledge practices to teach which is against the prescriptions of the biology curriculum under study (Effah, 2014).

5.2 Resources Available for the Teaching and Learning of Senior High School Biology

This research question focussed on the financial, human, material and infrastructural facilities. Sources of financial resources were through the schools‟ internally generated funds (IGF), PTA, Old Students Associations (Alumni), and Government through the Regional/Metropolitan/ Municipal or District Education Offices. The human resources included the biology teachers trained and untrained, laboratory technicians, laboratory assistants and laboratory attendants. The material resources also included equipment, apparatus, glassware, herbarium, chemicals, preserved specimen, models (human parts, organisms, skeletal system etc.) and biological charts. The infrastructural facilities include biology laboratory, preparation rooms, storerooms and ancillary rooms. Again, this research question was answered using the responses of teachers and students through several interviews, items in the questionnaire and also through observation of lessons and available equipment, specimen and charts in the various laboratories for practical lessons (Ayirah, 2015).

Results from Table 6, show that 72.4% of the respondents agreed that their schools had a laboratory for the teaching of biology with a mean level agreement of 3.71 and standard deviation of 1.56. Also, 60.0% of the respondents agreed that there were adequate reading materials available to the students to enhance the study of biology with a mean agreement of 3.34 and standard deviation of 1.42. Again, 44.1% of the total respondents agreed that the teachers in the school had the opportunity to receive professional upgrading towards the teaching of biology with mean agreement level of 3.30 and standard deviation of 1.23.

Science laboratory resources/ facilities could be human or material. The human resources had to do with personnel such as lecturers/teachers, laboratory technologist/assistants and students. The science laboratory material resources were those materials available to the science teacher for teaching and learning. They include textbooks, computers, thermometers, fire extinguishers, first aid kits, oven, incubators, chalkboards, model/mock-ups, television, radio and other electronic devices (Kankam, 2013).

From Table 9, the technical resource, material and human resource were the latent factors of resources for teaching biology. The first factor was made up of four outcomes whilst the second factors comprised of three outcomes as represented on the table. In Kenya, a study conducted revealed that achievements in national school examinations were influenced by the kind of school one attended, and the availability of resources in the school (Mucherah, 2008). This is not very different in Ghana, where achievements of SSS elective science students in biology appear to be determined by the kind of school one attends. This is because results released by the

West Africa Examinations Council (WAEC) in biology have consistently indicated that, schools that are well equipped in terms of science laboratories, textbooks, and qualified science teachers tend to produce better results while poorly equipped schools perform poorly in the subject (Addae-Mensah, 2003). While some authorities were of the view that schools with better achievements in biology have good infrastructure in terms of science laboratories, science textbooks and adequate number of qualified science teachers. It has also been noted that some schools with all these facilities do perform poorly in the subjects during WAEC examinations (Addae-Mensah, 2003)

From Table 10, the results show that out of 106 respondents, 100 representing 94.3% used the textbook Biology for Senior High School (GAST) for teaching and learning biology followed by 5 respondents representing 4.7% who were using the Modern Biology textbook for teaching and learning biology. Also, only one (1) respondent representing 0.9% used Functional Approach textbook for teaching and learning biology. However, 88 respondents out of the total respondents representing 83.0% indicated that they had a current syllabus for use in their school whiles 18 respondents representing 17.0% indicated that they do not have the current syllabus for use in their school.

Empirical studies conducted in relation to resource utilization in education have revealed that essential facilities were not always available in the schools. This inadequacy of teaching resources has been of serious concern to educators (Kennedy, 2009). Lyons (2012), stated that learning is a complex activity that involves interplay of student"s motivation, physical facilities, teaching resources, skills of teaching and curriculum demands. The process of managing and organizing resources is called resource utilization. The utilization of resources (laboratory facilities) in education brings about fruitful learning outcomes since resources stimulate students learning as well as motivating them (Asare, 2010).

Sazi (2013), stated that instructional resources include both human activities and material(s): without human resources, teaching and learning of practical skills would not take place effectively. On the other hand, human resources would not alone communicate learning.

Analysis of data from the interview schedule responses from teachers indicated whether their schools were well equipped with both human and material resources for the teaching of biology. Results from Table 11, showed that some schools were privileged to have both human and material resources to an extent this was indicated as 39.6% in Grade A schools. Responses from human resource and material resource were of the same percentage thus 30.2% in Grades B and C schools" respectively.

In another instance response from students were also collated and analysed. Students were asked whether they had a laboratory for biology lessons. From the results in Table 12, students" responses indicated that 62.1% stated that they had biology laboratories in their school for conducting practical lessons. Also 37.9% of the students indicated that there were no biology laboratories in their schools.

In another vein, some students interviewed were asked if they had a laboratory for biology lessons, they were then asked to show how often they went there for practical lessons. Results from Table 13 indicated that 43.5% of students indicated that their teachers did not conduct practical lessons for them, 22.6% of students also stated that they were taken through some practical lesson once in a term. Also 21.2% of students indicated that they had biology practical lessons monthly whilst 7.1% of students indicated that they had their practical lessons fortnightly. A rather small proportion of 5.6% stated that they had biology practical lessons weekly.

Biology students were asked if they had laboratory technicians in their schools. It was found out from their responses that 63.6% of students indicated that there were no laboratory technicians in their schools. Again, 36.4% of students indicated that laboratory technicians were in their schools as displayed in Table 14.

It was also observed that four of the schools in category C, in this study, did not have proper laboratories for practical work in biology. More so, there were only few biology laboratory technicians/assistants in some of the selected Senior High Schools. In most of the schools where laboratory technicians/assistants were present, students were not allowed to practice or manipulate equipment in the laboratory at their free time (spare time). Some of the reasons cited by the schools‟ authorities for not allowing the students to practice and manipulate equipment in the absence of the teacher and the laboratory technicians/assistants were that students might either steal some of the materials or misuse them (Tordzro, 2010).

Tordzro (2010), in his study stated that students learn faster when they are allowed to interact with materials and equipment. Teacher demonstrations prevented students from engaging in self-initiated explorations. Also field trips were very low and when inquired teachers indicated that there was no allocation of funds for such trips. Due to the lack of financial resources (imprest), most of the schools visited could not make provision for the construction of fishponds, plans to visit experimental/commercial farms or agricultural research institutes, forests and game reserves, man-made lakes, scientific and manufacturing organisations, seashores and hospitals as specified by the biology curriculum. This hindered the organisation of weekly biology practical activities as suggested by the biology curriculum. In view of these constraints, some biology teachers felt reluctant to use their scarce financial resources to conduct practical.

It was also observed that, most of the Senior High Schools selected have science laboratories, but these laboratories were in most cases used for theory lessons rather than practical activities. This was because such laboratories were ill equipped with materials and equipment necessary for practical lessons (Ahorlu, 2013). According to Ackon (2014), when materials are provided to meet the needs of a school system, students would not only have access to reference materials but the individual students would learn at their own pace to increase their academic performance.

5.3 The Types of Cognitive and Process Skills reflected by the Biology Teachers Instructional Activities in the selected Senior High Schools

Profile dimension describes the underlying behaviour for teaching, learning and assessment. The four learning behaviours, "knowledge", understanding", "application" and "process "are referred to as dimensions of knowledge. Knowledge is a dimension; application of knowledge is also a dimension. More than one dimension forms a profile of dimensions.

A central aspect of the biology curriculum is the concept of profile dimensions that should be the basis for the instruction and assessment. Learning may be divided into a number of classes. A student may acquire some knowledge through learning. The student may also learn to apply the knowledge acquired in some new context.

In biology, the three profile dimensions that have been specified for teaching, learning and testing are: Knowledge and Comprehension 30%, Application of Knowledge 40%, Practical and Experimental Skills 30%. Each of the dimensions has been given a percentage weight that should reflect in teaching, learning and testing.

The weights indicated show the relative emphasis that the teacher should give in the teaching, learning and testing processes. The focus of this curriculum was to get students not only to acquire knowledge but also to be able to understand what they have learnt and apply them practically. Combining the three dimensions in teaching would ensure that biology is taught not only at the factual knowledge level but that students would also acquire the ability to apply scientific knowledge to issues and problems as well as the capacity for practical and experimental skills that are needed for scientific problem solving.

The scientific inquiry skills (SIS) are a combination of practical and experimental skills that one needs to develop to become a good biologist. In view of the importance of the skills to the biologist, the biology curriculum has a unit in almost each section dubbed scientific enquiry skills to help the teacher consciously teach and facilitate certain activities to help the student develop these skills, which include practical and experimental skills.

Practical Skills involve the demonstration of manipulative skills using tools, machines and equipment for practical problem solving. The teaching of practical skills should involve projects, case studies and field studies where students would be intensively involved in practical work and in search for practical solutions to problems and tasks.

Experimental Skills involve the demonstration of the inquiry processes in science and refer to skills in planning and designing of experiments, observation, manipulation, classification, drawing, measurement, interpretation, recording, reporting and conduct in the laboratory/field. Practical and Experimentation Skills refer to the psychomotor domain as documented by Blooms taxonomy.

As stated in the Senior High School biology curriculum, the following are the skills that are required for effective practical and experimental; equipment handling, planning and designing of experiments, observation, manipulation, classification, drawing, measuring, interpretation, recording, reporting and conduct in laboratory/ field.

This research question was answered using some items in the teachers‟ questionnaire and some items in the interview schedule as well as observational data. Results from Table 15, show that 306 (86.5%) of the respondents were always allowed to ask questions to aid their understanding of concepts followed by 129 (36.5%) of the total respondents indicating that the teacher always involved them in practical activities. Also, 156 (44.1%) of the respondents‟ showed that the students sometimes worked in groups with others on the various topics followed by 112 (31.8%) respondents indicating that they sometimes read biology textbooks/hand-outs and make their own notes. However, 262 (74.1%) respondents always copied the notes that the teacher dictated/wrote on the board this results simply implies that students were not using any of the process skills. Finally, 269 (75.9%) of the total respondents indicated that their teachers always marked their quizzes and class exercises on time and gave them feedback accordingly.

From Table 18, the first factor would be named as teacher-learner activities, the second factor would be named as mode of assessments and the third would be named as time allocation. The first factor was made up of six outcomes, the second factor was made up of two outcomes and the third factor was also made up of two outcomes. A study conducted by Effah (2014), revealed that lessons varied from time to time and as such some lessons required the traditional approach of teaching in which information was imparted to learners, while other lessons learned more or towards an inquiry approach in which learner independence was promoted. Thus, students were required to collect, analyse and interpret biological data and also present data graphically, ask questions about phenomena, develop a sense of curiosity, creativity and critical mind as prescribed by the biology curriculum.

From Table 19, it could be seen that 93.4% of the respondents agreed that they had a good understanding of biology with an agreement mean level of 4.31 and standard deviation of .85. Also, 81.13% of the respondents agreed that during lesson delivery they introduced activities that promote mutual learning among students as well as encouraging students to initiate collaborative inquiry-based learning with a mean agreement of 3.89 and standard deviation of 0.99. Again, 77.4% of the respondents agreed that there were some challenges in relation to their teaching functions. This also recorded a mean level of agreement of 3.87 with a standard deviation of 1.05. However, 72.6% of the respondents agreed that the school"s curriculum is crowded with an agreement mean level of 4.09 and standard deviation of 1.12.

Diabene (2012), stated that process skills that scientists used for practicing and understanding science could be categorised into two (namely basic process skills and integrated process skills). The basic (Simpler) process skills provide a foundation for learning the integrated (Complex) skills. The basic skills that students are more likely to develop according to the syllabus are planning (defining the problem and thinking of ways to solve it through experimentation or some structured investigation) and observing (use of the senses, the microscope and other tools to make accurate observations of phenomena) (Shaw, 1983). The rest are manipulating (skilful handling of objects and tools to accomplish a task) and measuring (accurate use of measuring instruments and equipment). The integrated process skills include creative problem solving (this is a process of analysing a problem and choosing a noble but relevant solution in order to remedy or alter a problem situation) [MOESS, 2007].

Equipping students with the necessary process skills during instruction would forestall the memorisation of facts and rather encourage practical and active participation of all the learning processes that lead to the discovery of new knowledge Finley, Steward and Yaroch (1982). According to Ossei-Anto (1996), once science process skills are acquired, they become very powerful means of mastering content. Lee, Hairston, Thames, Lawrence and Herron (2002), also stated that science process skills ensure that students have meaningful learning experiences. All these give a lifelong experience to the students and condition them favourably to develop interest and have an inclination towards science.

Table 20 presented results on observation of teachers in terms of verbal activities. For activities such as "asks question requiring recall of previous learning", "ask questions requiring student‟s ideas", answering student‟s questions", answers own questions", "explains meaning of words", "comments on students work or answers", "asks pupils to comment on each other‟s answer", "gives information" and "gives instruction", all the schools performed such activities throughout the lesson. For "ask for report/description of work" and "asks questions for supervision/control (not topic)", Grade A schools performed such activity throughout the lesson, Grade B performed such an activity but not throughout the lesson, interestingly Grade C school did not perform such an activity throughout the lesson. For the activity "refers to worksheet", none of the schools performed such activity.

According to Saribas and Bayran (2009), teachers who are not confident about their capability to foster student learning through cognitive and process skills specified in the curriculum may dwell on negative images about their classrooms. Those with greater confidence are apt to task and think of their students as motivated to learn. Thus, teachers with the right beliefs about their abilities and about practical work would look beyond the challenges and still teach effectively. For "organises/distributes equipment", none of the schools performed such activity. This was as a result of inadequate equipment in the selected Senior High Schools (Asare, 2010).

Table 21 presented results on observation of teacher in terms of non-verbal activities. For activities such as "uses black board to record pupil findings/ideas", "uses black board for other purpose", "demonstrate activity/what to do", "listens to pupils" and "observe pupils/not interacting", all the schools performed such activities throughout the lesson. For "helps with use of specific equipment (not activity)", Grade A and B schools performed such activities but not throughout their lessons, but none of the Grade C schools performed such an activity.

The results obtained in this study was also in agreement with the work of Webb and Glover (2004), who cautioned that if educators do not have an appropriate understanding of the processes of science, they cope in ways that impoverish students learning opportunities and hence affects their academic achievements.

In conclusion, Asiamah (2011), stated that the role of process skills in this development of understanding was crucial. If scientific skills were not well-developed and relevant evidence not collected, then the emerging concepts would not help in the understanding of the world around us. It was to be noted, that the inclusion of science process skills as part of the curriculum, constituted the main goal of science education.

5.4 Aspects of Biology Lessons in Agreement with the Senior High Schools Biology Curriculum Prescriptions

This research question focused on the aspects of biology lessons in the selected schools that were in agreement with the Senior High School biology prescriptions. According to Eminah (2007), if a curriculum is not implemented as prescribed, educators and teachers claim it is ineffective. The main reason is that the curriculum prescriptions were not followed. Three different perspectives on curriculum implementation exist in the literature (Snyder, Bolin & Zumwalt, 1992) these are as follows: Fidelity approach- The curriculum is implemented in accordance with the original intentions of the developers; Mutual adaptation approach- adaptations of the intended curriculum are made by curriculum developers and practitioners and the Enactment approach- Teachers and students use the curriculum materials as tools to construct their own curriculum in the classroom.

The fidelity perspective is often implied in large-scale curriculum innovations, like in the context of centralised curriculum development systems in African countries. Teachers are supposed to implement the curriculum in line with the developers' intentions. Mutual adaptation suggests a process of negotiation between the developers and teachers in schools. Enactment usually takes place when small groups of teachers and students set out to develop and implement their own curriculum, rather than implement an external curriculum.

Mutual adaptation has emerged as a preferred model by many (Snyder, Bolin & Zumwalt, 1992) because it provides opportunities for adjustments in the curriculum in view of changing needs, interests, beliefs, local circumstances and skills of participants and organisations. The mutual adaptation perspective (as well as the enactment perspective) puts the curriculum development process at the centre of the implementation efforts. Projects reviewed by Snyder et al. (1992) and deemed to have been successfully implemented were characterised by a process of mutual adaptation. However, there are also undesirable scenarios of mutual adaptation (Clandinin & Connelly, 2000) such as non-implementation and co-optation. Non-implementation is simply when nothing changes, such as when the process of interaction between a project and an institute breaks down. Co-optation describes the situation in which the innovation is changed to the extent that project design conforms to the usual way of operation at the institution.

The aim of this research question was to establish how biology teachers" instruction was carried out in selected Senior High Schools in the Central Region. It sought to find out the methods of instruction mostly adopted by teachers during practical and theory lessons and the factors that account for the choice of particular instructional method. In answering this particular research question consideration was given to factors such as class size, presence and role of laboratory technicians/ assistants, the state of the laboratory among other pertinent issues raised.

The teaching of biology should be student-centred and activity oriented. The teacher acts as a facilitator. For effective teaching and learning in this course, the curriculum recommends that the schools should establish small botanical gardens, animals in a cage, fishpond and insects in a cage. Also plans must be made for visiting well- established experimental and commercial farms, agricultural research institutes and other institutions. Visits must also be planned to scientific and manufacturing organisations, forest and game reserves, man-made lakes, the seashore, hospitals, where students will observe scientific work and the application of science in manufacturing, different types of habitats and interactions in nature. Video clips could also be shown where these are available. The provision of well-equipped laboratories will enhance teaching and learning of biology. It is also suggested that well trained laboratory technicians be made available to play complementary role to the teacher (Sazi, 2013).

Felder (1993), said "if learners learning styles are compatible with teachers teaching styles, they were likely to retain information longer, apply it more effectively and is also inclined to have more positive attitudes towards the subject than anyone who experiences learning mismatch".

However, if learner-centred environments are to be created, then biology teachers must be made to feel confident in the handling of interpersonal behavior and interact cordially with their students. Teachers can evoke the interest in students to learn biology when they attempt to create and maintain favourable classroom learning environments through positive interpersonal relationships as prescribed by the biology curriculum, which categorically states that biology should be student-centred, and activity oriented.

Table 22 examined the suggestions of the biology curriculum for Senior High Schools. From the Table it could be deduced that, the entire seven (7) Grade A schools visited had botanical gardens, six (6) had animals in cages for biology practical, three (3) had fish ponds and all seven schools did not have insects in a cage. With regards to planned visits to seven suggested places of academic importance by the curriculum schools"; the first school had three (3) of such visits, the second had four (4), the third had three (3), the fourth had one (1), the fifth had three (3), the sixth had four (4) and the seventh had two (2) of such visits.

With regards to Grade B schools two schools out of the seven (7) had botanical gardens, three (3) had animals in a cage and only one (1) school had a fishpond. With regards to planned visits to the seven suggested places of academic importance by the curriculum only two schools performed such an activity once to an Agricultural Research Institute and the seashore respectively.

Grade C schools visited did not have botanical gardens, animals in a cage, fishpond and insects in a cage. More to that, places of academic significance to be visited was executed by only one (1) school, which was to a well-established experimental and commercial farm. The rest of the schools did not organise any of such visits as suggested by the biology curriculum. Observational, recording reporting, interpretation and classification skills would be achieved if students embark on these educational tours/trips. Knowledge-based expansion would also occur because students would apply what they might have studied theoretically in class to what they had seen on the field.

Data from Table 23 shows that out of 106 respondents, 96 representing 90.3% used the Biology for Senior High School (GAST) for teaching and learning biology followed by 7 respondents representing 6.5% using the Modern Biology textbook for teaching and learning biology. Also, only 3 respondents representing 3.2% used Functional Approach as the textbook for teaching and learning biology. However, 85 respondents out of the total respondents representing 80.6% indicated that they had a current syllabus for use in their school whiles 21 respondents representing 19.4% indicated that they don"t have the current syllabus for use in their school. Modern Biology, Biology for Secondary Schools are recommended textbooks used as references in the Senior High School biology curriculum, using these books are in agreement with the Senior High School biology prescriptions.

The teacher respondents were asked to provide and indicate whether the SHS programme should be allowed to stay and were asked to mention two areas they think needs improvement or innovation and how they wish it should be done. From the responses, one respondent indicated, activities on key topics should be made more practical and applicable in everyday situation and content of some key topics should be revised so the two and half years will be adequate to cover the syllabus. Another teacher respondent, added, that adequate provision of TLMs, laboratory equipment and laboratory technicians should be provided. Teachers should also be given copies of the WAEC syllabus and better biology textbooks. Also, another explained that in classification of organisms, for example specimen are learnt in abstract without seeing the real organisms. GES should release funds to undertake field trips. Also, videos can be made to give more meaning to topics in evolution since it is so abstract.

From Table 24, it could be seen that 335 respondents out of the total respondents of 354 representing 94.7% described the type of interaction in their classroom as mostly teacher-student centred. Also, 12 respondents representing 3.5% described the type of interaction in their classroom as mostly student-student centred whiles 7 respondents representing 1.8% described the type of interaction in their classroom as mostly student-resources centred. However, none of the respondents indicated that the interaction in their classroom was mostly teacher- resources centred.

This finding was in agreement with Bennet (2003) who noted that simply telling or explaining concepts to learners is no guarantee that they would receive the message or understand it. During the observation and interview it transpired that most teachers structured their biology lessons around teacher talking and students responding to teachers" questions in some instances. Some teachers also felt that their learners learn best through memorization (a passive process of learning by which the learners soon forget what they had learnt), an approach they claimed to have used since the commencement of their teaching careers. Finally, due to inadequate financial resources, most of the selected Senior High Schools visited could not fulfil the curriculum prescriptions by organising weekly practical lessons as suggested for effective teaching, learning and assessment of the biology course.

5.5 Aspects of Profile Dimensions Specified in the Biology Curriculum Exhibited by the Students during Practical Activities

Some facilities such as TLMs, equipped laboratories could be available and adequate but might not be put to use by the teachers. Similar findings were made by Umeh (2002), who stated that audio visual aids such as computers and projectors were not utilized in schools due to lack of knowledge on the proper use of such resources for teaching. Onyeji (2004), had earlier reported that none of these new media (electronics) was available, accessible or used in communicating science, technology and mathematics (STM) in secondary schools this was also in the Ghanaian context. Physical laboratory facilities are the fundamental factors in ensuring efficient learning and achievements of the students. All facilities should be provided to the schools for the students‟ better, concrete, and real experiences. Leeper, Dales and Skipper (1968), stated that the child learned through concrete rather than abstract experiences as there are learners who use different cognitive skills for learning, such as seeing, hearing feeling and touching skills.

In biology, the three profile dimensions that have been specified for teaching, learning and testing are: Knowledge and Comprehension 30%, Application of Knowledge 40%, Practical and Experimental Skills 30%. Each of the dimensions has been given a percentage weight that should reflect in teaching, learning and testing. The weights indicated shows the relative emphasis that the teacher should give in the teaching, learning and testing processes. The focus of this curriculum was to get students not only to acquire knowledge but also to be able to understand what they have learnt and apply them practically. Combining the three dimensions in teaching would ensure that biology is taught not only at the factual knowledge level but that students would also acquire the ability to apply scientific knowledge to issues and problems as well as the capacity for practical and experimental skills that are needed for scientific problem-solving.

Table 25 presented results on observation of groups relating to task assigned by the teachers. For "making observations", it can be seen that only grade A school performed such an activity in the middle of the lesson. None of the Grade B and C schools performed such an activity. In the "raising of questions", Grade A schools performed such an activity throughout the lesson, as grade B schools performed it during the middle of the lesson. None of the Grade C schools performed such activity. However, none of the schools performed "suggesting hypothesis", "predicting", "finding pattern/ relationship", "devising and planning investigations", "handling material/ equipment" and "measuring/ calculating and recording".

Most biology teachers in the selected Senior High Schools seemed to ignore the practical aspect due to non-availability of equipment, poorly resourced laboratories coupled with their perception that the biology syllabus was broad. A perception, which in the opinion of the researcher actually influenced how these teachers, taught the subject. This behaviour on the part of teachers with regards to the approaches used in teaching of the sciences and most especially biology in this regard does not give room for students to develop their creative abilities as opined by Adepoju (1991). Similarly, Young (1990), emphasised that teachers in science education, should guide students to fish out for information on their own through activities rather than feeding them with information. He explained that when students were involved in most of the activities during lessons, not only do they learn to be inquisitive and creative but they also acquire knowledge more meaningfully. This knowledge acquired is then applied to problem-solving, a profile dimension referred to as Application of Knowledge. This is in accordance with the biology curriculum prescription, which categorically suggests that the teacher should act as a facilitator for effective teaching and learning in this course. Practical activities should therefore be used by teachers to help their students achieve better results in biology.

Table 26 presented results on observation of group relating to teacher. For "asking about the topic", "answering teachers question in terms of fact and recall", "answering teachers" question in terms of ideas", "reporting/explaining actions" and "listening to the teacher", all the schools experienced such activities throughout the lesson. On the contrary, Grade A and B schools experienced "asking for help about procedure" throughout the lesson, but none of the Grade C schools experienced such activity. This was because as shown in Table 4, 7 (50%) of the teachers in Grade C schools were professionally trained and the same number also lacked professional training. From the results gathered, it was found out that a fair number of teachers were informed of the science process skills and applied them during lessons as represented on the table. Elements such as conduct in the laboratory, observation, reporting, recording and interpretation just to mention but a few of the process skills recommended by the biology curriculum.

Table 27 presented results on observation of students" group relating to each other. For "organising tasks in terms of co-operatively" and "talk about record/report", none of the schools performed such activity. For "organising task in terms of argument" and "non-topic/task talk", only one Grade B school performed such an activity between the 11th and 20th minutes of the lesson. For "talk about topic/task", only Grade A schools" performed such an activity between the 11th and 30th minutes of the lesson. For "listening responding to others ideas", all the schools performed such activity. For "independent working", all the schools performed such an activity but not throughout the lesson. For numbers activity/purposefully working", only Grade A schools" performed such an activity throughout their lessons.

5.6 Support Services and Capacity Enhancing Activities Organised for Biology Teachers in the Senior High Schools

Borich (1977), stated that teachers must have three competencies, which were meant to provide insight into their practicum. These competencies were knowledge competency, which had to do with teachers' content knowledge, performance competency this had to do with teachers' pedagogy and consequences competency, which had to do with teachers teaching effectiveness. These are important factors for professional qualifications and not academic qualifications since all teachers in the study were degree holders. Some of the teachers in the study were untrained and as such lacked pedagogy.

School leaders may opt to invest in a cadre of specialized science educators—science specialists, teacher leaders, coaches, mentors, demonstration teachers, lead teachers-rather than, or in conjunction with, organized forms of teacher opportunities to learn. The term "science specialist" is used to capture varied arrangements of organizing and distributing teacher expertise (Loucks-Horsley *et al.*, 1998; Lieberman, 1992). Subject matter specialist teachers may serve as leaders of groups of teachers-working with individual teachers in classroom settings, working with groups of teachers in professional development settings, or working with teachers, administrators, community members, or students on issues or programs that indirectly support classroom teaching/learning experiences (Lord & Miller, 2000).

It is important to have specialist science teachers to ensure effective science teaching in schools. Science Community Representing Education (SCORE) (2011) uses „specialism" to refer to the subject knowledge gained by a teacher through their academic and professional qualifications and experience and recommend the use of teachers who are subject specialists. Dudu (2013) and Makgato and Mji (2006), showed concern on the lack of problems encountered by qualified science teachers. There are a number of studies that reveal the existence of weak teacher content knowledge (Stols *et al*. 2007; Taylor & Moyana 2005). The issue of teachers" content knowledge should be addressed in order to ensure quality teaching and learning of biology in the selected Senior High Schools.

Some research findings indicated that teachers do not respond to sustained professional development by taking their new knowledge and skills to other schools, but rather by staying and creating new benefits where they were. One study found that schools that provided more support to new teachers, including such professional development activities as induction and mentoring, had lower turnover rates (Ingersoll, 2003, p. 8). In addition, some researchers argue that, although professional development expended resources (time, money, supplies), it also created new human and social resources (Gamoran, Anderson, Quiroz, Seceda, Williams & Ashman 2003).

This research question was answered using various items in the teachers" questionnaire and some items in the interview schedule. Results from Table 28 show biology teachers who had received in-service training. It is evident from the results that 65 (61.3%) in the majority had undergone in-service training whilst 41 (38.7%) of the total number of teachers said they had not received any in-service training in biology. In that direction, in-service training should be organised regularly for biology teachers since teachers are not finished products and that knowledge is dynamic.

Table 29 shows that, the main organisers of in-service training were GAST which accounted for 50.1% of the total number of in-service programmes attended by the respondents. Next was STMIE, which also accounted for 22.6 % in organising in-service training programmes. Government and other stakeholders in education can take it upon themselves and organise in-service training programmes regularly for the biology teachers to update their knowledge-base in the subject area.

Finally, Table 30 examined how regularly biology teachers attended in-service training programmes. Teachers felt that in-service training programmes were not organised frequently. Approximately, 77 (73%) of the respondents attended in-service programmes once a while as displayed in Table 30.

CHAPTER SIX

SUMMARY, CONCLUSIONS, RECOMMENDATIONS, AND SUGGESTIONS FOR FURTHER STUDIES

6.0 Overview

This chapter offers summaries and details of additional findings, conclusions and recommendations. It also gives suggestions for further studies.

6.1 The Summary

This section recapitulates the main findings of the study:

- The study revealed that academic and professionally qualified biology teachers were clustered in grades A and B schools. Most of the teachers who pursued Masters Degrees also diverted from science education (biology) and specialised in Molecular biology, Zoology, Aquaculture and fisheries among others. Notable was the WAEC biology Chief examiner whose second degree was in Fisheries and Aquaculture.
- Some laboratories were not fully equipped with equipment, apparatus, specimen and charts for biology lessons. Teachers and students in the study also indicated that the few apparatus, equipment and learning materials available were used only in demonstrations. Teachers lamented that due to large class sizes, limited time and resources available; demonstrations were mostly used during practical lessons. In view of these skills such as measuring, observation, recording, reporting, interpretation and drawing skills were scarcely used by students as prescribed by the biology curriculum.
- Another major finding from the study revealed that most of the Senior High Schools selected have science laboratories, but these laboratories were in most

cases used for theory lessons rather than practical activities. This was because such laboratories were ill equipped with materials and equipment necessary for practical lessons.

- This study also revealed that most of the teachers used the teacher-centred method of teaching and learning, where lecture and discussion were the mostly used methods of instruction instead of student-centred and activity-oriented approaches prescribed by the biology curriculum.

6.2 Details of Additional Findings

- Some teachers were of the view that they need to be motivated financially to go the extra mile.
- Time allocated for practical activities varied from school to school.
- Some teachers also said the duration of the SHS programme was short and due to that most of the topics and practical activities were not completed.

6.3 Conclusions

This study provides credible empirical evidence on the evaluation of the Senior High Schools biology curriculum in the Central Region of Ghana. Data gathered in this study provide vital information to curriculum designers, implementers and planners just to mention but a few, so that all the findings will be tailored specifically to address the shortcomings occurring in Senior High School biology classrooms.

Firstly, based on the findings with regards to research question 1, biology teachers in Categories A & B schools" tended to be academically and professionally qualified to implement the biology curriculum in the Senior High Schools, whereas with regards to category C schools, most of the teachers were not professionally qualified.

In this study, from the data gathered, all categories of schools were complaining of infrequent supplies of resources for effective teaching and learning of biology from the Ministry of Education and Ghana Education Service. Results from the discussion clearly indicated that facilities; materials and human resources in grades A and B schools were somehow adequate but those in the Grade C schools were inadequate.

Research question 3, was concerned with the cognitive and process skills that were reflected by the biology teachers" instructional activities. The process skills that were observed in this study included drawing, interpretation, measurements, recording, reporting, classification and observation. The cognitive skills on the part of the teachers were found to be standard in Grade A schools since most of the teachers were academically and professionally qualified. In some of the grades B and C schools some teachers, although academically qualified seemed not to be professionally qualified. They lacked qualifications in methodology, due to that they lacked confidence and their lesson delivery was poor.

On the aspects of the biology lessons that were organised in agreement with the curriculum prescriptions, it was found that although the teaching methods varied, most teachers practiced the lecture method of teaching and learning whereas the biology curriculum categorically states that biology should be student-centred and activity-based.

From the study and results gathered with regards to research question 5, it was clear that, most of the schools did not make provisions for practical activities for the biology students to enable them expand their knowledge and experimental skills. To a greater extent, theoretical knowledge gets strengthened when relevant practical activities are organised to support the content taught in the classrooms.

Finally, support services and capacity-enhancing activities organised for biology teachers in the Senior High Schools were low. This is a big demotivation and the various stakeholders need to look critically into this aspect of professional development of the biology teachers to enhance effective teaching and learning. This will in turn ensure high standards in the teaching and learning of biology in Senior High Schools.

6.4 Recommendations

Based on the findings of this study the following recommendations are made:

- From the study most biology teachers in categories A and B schools and a few in Grade C schools were academically and professionally qualified to implement the Senior High School biology curriculum. It is recommended that professionally and academically qualified biology teachers in the Central Region should be evenly distributed so that they would not be concentrated in only a few schools while others lacked them. Also only qualified and experienced teachers should handle Senior High School students in order to build a good and strong foundation for the students. Biology teachers with both professional and good content knowledge qualifications are to be recruited to teach at SHS.
- No practical lessons were observed in the selected Senior High Schools and this was contrary to the curriculum prescriptions; as teachers were complaining bitterly about the time frame and provision of resources for conducting practical lessons. It is hereby recommended that the Ministry of Education (MOE)/Ghana Education Service (GES), provide adequate resource materials to meet the curriculum prescriptions. It is also recommended that biology teachers always use the triple periods allocated on the timetable for laboratory activities. Also

supervision of the sciences and biology in particular should not only focus on the coverage of scheme of work and weekly lesson plans as recorded by the teachers. Supervisors should endeavor to encourage the teachers‟ use of scientific methods such as laboratory method.

- Biology teachers should always use their immediate environment to teach as it contains a lot of material resources for effective teaching of the concepts in the subject. The functionality and duration of equipment should be taken into consideration so as to utilize it judiciously. There is need for organizations, government, Parent Teacher Association, Voluntary Organizations and Philanthropists to join hands in procuring necessary biology materials and resources in Senior High Schools. Biology teachers should set up simple aquarium, vivarium and botanical gardens in schools. The government should also supply basic resources to schools through special funds.
- Some of the process skills exhibited by the biology students during instructional activities were equipment handling, planning and designing of experiments, observation, classification, drawing just to mention but a few. It is therefore recommended that the basic rubrics governing biology theory and practical lessons should be demonstrated always to develop students‟ science process and psychomotor skills. Also the "Biology Learning and Teaching Resource Kit" already developed should be further updated to meet with the latest curriculum developments to enhance the understanding of the subject.
- To facilitate the implementation of the curriculum, professional development programmes should be organized for biology teachers. The Ministry of Education and Ghana Education Service should make appropriate plans to expose biology teachers to training workshops on improvisation in order to

update their techniques for improvising specific equipment. Government should make funds available and sponsor the teachers" attendance at conferences, seminars and workshops on biology material resource production utilization and management. Biology teachers should have regular in-service courses to re-orient them on their teaching methodologies and acquaint them with the use of new chemicals and new equipment so that they sustain the interest of all learners, in the science subjects, particularly girls. More female teachers in SMT must be trained to handle girls and act as role models. Biology teachers should be adequately motivated through enhanced salaries, allowances and incentives for them to improvise and use laboratory method.

6.5 Suggestions for Further Studies

Based on the findings of this study, the following suggestions for further study were made:

i. A study should be conducted to investigate the classroom implementation of the SHS biology curriculum in other regions of Ghana.

ii. A study should be conducted to investigate the professional competence of SHS biology teachers in selected schools.

iii. A survey of the educational provisions required in the various schools (Grades A, B and C) on the successful implementation of the SHS biology curriculum should be conducted.

iv. A study of the effect of untrained (non-professional) biology teachers on SHS students" cognitive achievement should be carried out.

v. An assessment of the support services and capacity enhancing activities required by SHS biology teachers should be carried out.

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APPENDIX A

EVALUATING THE CLASSROOM IMPLEMENTATION OF SENIOR HIGH SCHOOLS' ELECTIVE BIOLOGY CURRICULUM

QUESTIONNAIRE FOR STUDENTS

Students‟ Questionnaire

Dear respondent,

It is with great pleasure that I am interacting with you through this questionnaire. This research is being conducted as a requirement in partial fulfilment of my PhD study in Science Education at the University of Education, Winneba, Ghana. This questionnaire seeks information on the topic: ***Evaluating The Classroom Implementation of Senior High School Elective Biology Curriculum in the Central Region of Ghana.*** The devised questions are for research purposes only and the responses will be treated with utmost confidentiality. You will not be penalized for any answer you give. There is no right or wrong answer. What matters is your own experience and truthfulness expressed in the responses you provide for the items in this questionnaire. The exercise is purely academic. Any information given is solely for academic purposes. The questions are intended to seek your views on the classroom implementation process of the Elective Biology programme. You are highly assured of confidentiality and anonymity. For any further enquiry, feel free to contact the researcher using any of the contacts:

Mobile Number: 0244773097/0204020136 Email: em_khalish@yahoo.com

Thank you very much for your time and participation.

SECTION A:

1. Coded name of the school...
2. Sex of student...

SECTION B: Resources Available for Teaching Elective Biology

Please tick (√) inside the box that corresponds to your choice of response. Your objectivity and fairness in response selection will be highly recommended and appreciated. The rating is as below:

APPENDIX A: CONTINUATION

SD = Strongly Disagree; D = Disagree; NS = Not Sure; A = Agree; SA = Strongly Agree

SN	RESOURCE ITEM DESCRIPTION	SD	D	NS	A	SA
1.	Is the school well-resourced for the teaching of biology?					
2.	Do the facilities in this school promote the teaching of biology?					
3.	Does the school have a laboratory for the teaching of BIOLOGY?					
4.	Is the laboratory well equipped for the teaching of biology?					
5.	Are there adequate reading materials (textbooks, handouts, notes etc.) available to you to enhance your study of biology?					
6.	Is the school library well stocked with biology books for your reference during private studies?					
7.	Do teachers in this school have the opportunity to receive professional upgrading towards the teaching of biology?					

SECTION C: How often do the following activities occur during your biology lessons?

	During my biology lessons	Always	Most of the time	Some times	Rarely	Never
8.	The teacher makes use of sufficient resources (pictures, tables, animations, computers, etc.)					
9.	I am allowed to ask questions to aid my understanding of concepts.					
10.	The teacher involves me in practical activities					
11.	I work in groups with other classmates					
12.	I hold discussions with others on the various topics					

APPENDIX A : CONTINUATION

13.	I read biology textbooks/handouts and make my own notes.					
14.	I copy the notes that the teacher dictates/writes on the board.					
15.	Enough time is allocated on the school time table for the teaching and learning of biology					
16.	The teacher allows me to handle materials and equipment during practical lessons.					
17.	The teacher uses various tools (quizzes, exercises, assignments, projects, etc.) to assess my work					
18.	The teacher marks my quizzes and class exercises on time and gives me a feedback accordingly.					

SECTION D:

19. In totality, I can describe the type of interaction in my biology classroom as mostly:

I) Teacher - Students Centred II) Student – Student Centred

III) Teacher – Resources Centred IV) Student – Resources Centred

20. A) Do you have some challenges in the programme you are pursuing?

YES [ ] NO [ ]

B) If yes, mention two of the challenges

i) ....

ii)

21. Suggest ways by which you think the challenges you have identified in item 24 B) above can be minimized or controlled

....

....

....

APPENDIX B

EVALUATING CLASSROOM IMPLEMENTATION OF SENIOR HIGH SCHOOLS' ELECTIVE BIOLOGY CURRICULUM

QUESTIONNAIRE FOR TEACHERS

Teachers" Questionnaire

Dear respondent,

It is with great pleasure that I am interacting with you through this questionnaire. This research is being conducted as a requirement in partial fulfilment of my PhD study in Science Education at the University of Education, Winneba, Ghana. This questionnaire seeks information on the topic: ***Evaluating The Classroom Implementation of Senior High School Elective Biology Curriculum in the Central Region of Ghana.*** The devised questions are for research purposes only and the responses will be treated with utmost confidentiality. You will not be penalized for any answer you give. There is no right or wrong answer. What matters is your own experience and truthfulness expressed in the responses you provide for the items in this questionnaire. The exercise is purely academic. Any information given is solely for academic purposes. The questions are intended to seek your views on the classroom implementation process of the Elective Biology programme. You are highly assured of confidentiality and anonymity. For any further enquiry, feel free to contact the researcher using any of the contacts:

Mobile Number: 0244773097/0204020136 **Email: em_khalish@yahoo.com**

Thank you very much for your time and participation.

SECTION A:

a) Coded Name of School................................ B) Coded Name of Teacher.............

C) Sex........................... d) Qualification: Academic/ Professional..................

e) Area of Specialization...

f) Number of years teaching Senior High School Elective Biology..............................

g) Any other science subject being taught apart from Biology………………………...

APPENDIX B : CONTINUATION

SECTION B :

Please tick (√) inside the box that corresponds to your choice of response. Your objectivity and fairness in response selection will be highly recommended and appreciated. The rating is as below:

SD = Strongly Disagree; D = Disagree; NS = Not Sure; A = Agree; SA = Strongly Agree

SN	ITEM DESCRIPTION	SD	D	NS	A	SA
1.	Does your school have adequate equipment, facilities, laboratories and general resources required for implementing the biology programme?					
2.	There are some challenges in the cause of teaching functions					
3.	There is enough support for teachers from both within the school and outside, e.g. opportunities to receive ongoing curriculum professional support					
4.	There is enough time available for preparing and delivering the requirements of the biology course, e.g. enough time to develop your own understanding of the subject you are required to teach					
5.	Have you ready access to science materials and resources in this school to enable you implement the biology programme as demanded by the objectives of the curriculum?					
6.	Is the school curriculum crowded? Does Biology suffer because of this?					
7.	During lesson delivery do you introduce activities that promote mutual learning among students as well as encourage students to initiate collaborative inquiry-based learning?					
8.	Does the biology programme enable students to acquire the relevant manipulative skills that enable them to handle and operate science equipment and materials effectively at the end of the lessons?					

APPENDIX B : CONTINUATION

SECTION C :

9) What are the textbooks available for teaching and learning biology?

a) Modern Biology b) Functional Approach c) Biology for SSS (GAST)

d) Other (Specify)....

10) Do you have a current syllabus for use in your school? [Yes] [No]

11) How accessible is the biology syllabus to you?

a) I have a copy myself b) A copy is always available for reference

c) I use the GAST textbook in place of the syllabus

d) I teach without reference to the syllabus

12) Are the contents of the biology syllabus available to you in line with the recommended textbooks?

[Completely in line] [Partially in line] [Not in line]

13) How often do you assess your students understanding of the principles and concepts taught them in biology? Please ***circle*** the letter(s) that corresponds to your choice of response.

A) At the end of each lesson. B) At the end of teaching each topic.

C) During organized term quizzes. D) Before the start of end of term examinations.

E) End of term examinations.

14) How do students take notes in class?

a) Teacher dictates notes b) Students makes their own notes from textbooks

c) Students take notes during the lesson d) Any other (Specify)………

SECTION D:

15) In your opinion, do you think the Senior High School Biology programme is a good initiative and should be allowed to stay? YES [ ] NO [ ]

16) If you think the programme should be allowed to stay, mention two areas that you think needs improvement or innovation and how you wish it should be done.

i. ....

....

ii. ....

....

APPENDIX C

INTERVIEW SCHEDULE FOR STUDENTS

The purpose of this interview is to help study the way the elective biology programme is being implemented at this School. Kindly answer the following questions. Your responses will be treated very confidentially. Thank you for your cooperation.

Interview Items

1. Do you have adequate biology teachers in this school?
2. Do you have laboratory technicians in the school?
3. a) Do you have a laboratory for biology lessons?

   b) If yes, how often do you go there for practical lessons in biology in a week?
4. Is the laboratory well equipped enough with specimen, equipment, charts, etc. for your practical lessons in biology?
5. Do your teachers use materials and equipment other than those in the laboratory during biology lessons?
6. Are you given the opportunity to handle the teaching and learning materials during biology lessons?
7. a) Do you have some challenges with regards to the study of biology in this school?

   b) If yes, mention two of the challenges.

   i. ....

   ii...
8. How do you think the challenges that you have mentioned could be minimized?

   ....

   ....

APPENDIX D

INTERVIEW SCHEDULE FOR BIOLOGY TEACHERS

The purpose of this interview is to help study the way the elective biology programme is being implemented in this school. Kindly answer the following questions. Your responses will be treated confidentially. Thank you for your cooperation.

1. Is the school well equipped with both human and material resources for the teaching of biology?
2. a) Does the school have a biology laboratory?
   b) If yes, is the laboratory equipped with adequate specimen, equipment and other materials for effective organisation of practical lessons in biology?
3. Are there regular supplies of laboratory materials and equipment in the school from MOE/GES?
4. Do you allow your students to interact with teaching and learning materials during biology lessons?
5. How often do you organise practical lessons in biology in a week?
6. What are some of the challenges that you encounter during biology lessons?
7. Suggest ways by which the challenges that you have identified could be minimized.
8. Do you organise visits to established and commercial farms, scientific and manufacturing organisations forest and game reserves, man-made lakes, seashore and hospitals?

APPENDIX E

OBSERVATION INSTRUMENT

Teacher ………………………………………. Topic…………………………………

School and Class ………………………… Date: ……………………………..........

Duration: ……………………………………..

Form 3

Observation of whole class

In the space below please sketch the classroom and showing layout of tables and other major pieces of furniture. Mark position of pupil groups and number the groups with X‟s. Then use the plan to follow the teacher‟s movements, drawing lines to routes taken and dots to indicate pauses. For pauses less than 2 minutes put a small dot. For pauses of 2 – 4 minutes a dot in one circle, for 4- 6 minutes a dot in two circles and so on. Use some system of numbering or lettering to indicate the sequence of movement.

APPENDIX E: CONTINUATION

Teacher ……………………….. Topic…………………………………...
School and Class …………………………… Date: ……………………………

FORM 1 OBSERVATION OF GROUP

	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	17-18	19-20	21-22	23-24	25-26	27-28	29-30	31-32	33-34	35-36	37-38	39-40	41-42	43-44	45-46	47-48	49-50
Relating task: 1. Marking observations																									
2. Raising questions																									
3. Suggesting hypotheses (explanations)																									
4. predicting																									
5. Finding patterns/relationship																									
6. Devising and planning investigations																									
7. Handling material/ equipment																									
8. Measuring/ calculating																									
9. Recording																									
10. Other (write in)																									
Relating to teacher: 11. Asking about topic																									
12. Asking for help about procedure																									
13. Answering teacher‟s questions (fact/recall)																									
14. Answering teachers questions (ideas)																									
15. Reporting/ explaining actions																									
16. Listening to teacher																									
17. Other (writer in)																									
Relating to each other: 18. Organising task (co -operatively)																									
19. Organising task (argument)																									
20. Talk about topic/task																									
21. Talk about record/report																									
22. Non – topic/task talk																									
23. Listening/responding to others ideas																									
24. Independent working																									
25. Number actively/ purposefully working																									
26. Other (write in)																									

APPENDIX E: CONTINUATION

Teacher ……………………….. Topic………………………………..
School and Class …………………………… Date: ……………………………

FORM 2 OBSERVATION OF TEACHER

	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	17-18	19-20	21-22	23-24	25-26	27-28	29-30	31-32	33-34	35-36	37-38	39-40	41-42	43-44	45-46	47-48	49-50
Verbal Activities 1. Asks question requiring recall of previous learning																									
2. Asks questions requiring pupils ideas																									
3. Asks for report/description of work																									
4. Asks questions for supervision/control (not topic)																									
5. Answers pupil"s question																									
6. Answers own question																									
7. Explains meaning of words																									
8. Comments on pupils" work or answers																									
9. Asks pupils" to comment on each other"s answers																									
10. Gives information																									
11. Gives instruction																									
12. Refers to worksheet																									
13 Other (write in)																									
Non – Verbal Activity 14. Uses black board to record pupil findings/ideas																									
15. Uses black board for other purpose																									
16.Organises/distributes equipment																									
17. Demonstrates activity /what to do																									
18. Helps with use of specific equipment (not activity)																									
19. Listens to pupils																									
20. Observes pupils/not interacting																									
21. Other (write in)																									

APPENDIX F

TABLE FOR DETERMINING THE RANDOM SAMPLE SIZE

The size of the population and amount of error determines the size of a randomly selected sample. This table helps the researcher determine (with 95 percent certainty) what the results would have been if the entire population had been surveyed.

Table for Determining the Random Sample Size from a Determined Population

If your Population is:	Then your random Sample size should be:
10	10
15	14
20	19
25	24
30	28
35	32
40	36
45	40
50	44
55	48
60	52
65	56
70	59
75	63
80	66

APPENDIX F: CONTINUATION

85	70
90	73
95	76
100	80
110	86
120	92
130	97
140	103
150	108
160	113
170	118
180	123
190	127
200	132
210	136
220	140
230	144
240	148
250	152
260	155
270	159

APPENDIX F: CONTINUATION

280	162
290	165
300	169
320	175
340	181
360	186
380	191
400	196
420	201
440	205
460	210
480	214
500	217
550	226
600	234
650	242
700	248
750	254
800	260
850	265
900	269

APPENDIX F: CONTINUATION

950	274
1,000	278
1,100	285
1,200	291
1,300	297
1,400	302
1,500	306
1,600	310
1,700	313
1,800	317
1,900	320
2,000	322
2,200	327
2,400	331
2,600	335
2,800	338
3,000	341
3,500	346
4,000	351
4,500	354
5,000	357

APPENDIX F: CONTINUATION

6,000	361
7,000	364
8,000	367
9,000	368
10,000	370
15,000	375
20,000	377
30,000	379
40,000	380
50,000	381
75,000	382
1,000,000	384

APPENDIX G

LETTER OF INTRODUCTION

UNIVERSITY OF EDUCATION, WINNEBA
DEPARTMENT OF SCIENCE EDUCATION
P. O. BOX 25, WINNEBA TEL. NO. 0202041079
Website: www.uew.edu.gh Email: science@uew.edu.gh

Our Ref:

Your Ref: *Date: Sept. 30, 2016*

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

LETTER OF INTRODUCTION
AMOAH, JOHN E. M. (STUDENT INDEX NO. 9150130001)

We write to introduce the above student who is a Ph.D student of the Department of Science Education at the University of Education, Winneba. Please, he has requested for an introductory letter to enable him conduct a research on ***"Evaluating Classroom Implementation of Senior High School Elective Biology Curriculum in the Central Region of Ghana"*** at your outfit.

We should be grateful if you could grant him the required assistance.

Thank you for your cooperation.

Yours faithfully,

VICTOR ANTWI (Ph.D)
AG. Head of Department

APPENDIX H

RE: LETTER OF INTRODUCTION

ASSIN MANSO SENIOR HIGH SCHOOL

MOBILE: 0244598406 E Mail: assin_manso@yahoo.com

Bankers: GCB Assin Fosu
ADB Assin Fosu
Assinman R.B - Assin Manso

Our Ref; ...MSS:45/UN/2006/...
Your Ref;..................................
DATE: 24th October, 2016

Animia Wie Nkonimdie

(VICTOR ANTWI (Ph.D)
UNIVERSITY OF EDUCATION
P. O. BOX 25,
WINNEBA.

RE-LETTER OF INTRODUCTION
AMOAH, JOHN E.M. (STUDENT INDEX NO.91501`30001)

I write to acknowledge receipt of your letter dated September 30, 2016 in respect of the above student.

I am glad to inform you that management has accepted your request.

Counting on your usual co-operation.

Thank you.

HEADMISTRESS
ASSIN MANSO SNR. HIGH SCHOOL
ASSIN MANSO

(MS. GRACE OHEMENG)
HEADMISTRESS.

Animia Wie Nkonimdie

P.O.Box 30, Assin Manso - Central Region