UNIVERSITY OF EDUCATION, WINNEBA

AN ASSESSMENT OF THE AVAILABILITY AND UTILISATION OF BIOLOGY LABORATORY FACILITIES BY TEACHERS IN SELECTED SCHOOLS IN THE CENTRAL REGION OF GHANA

RUTH OTISON ASANTE

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RUTH OTISON ASANTE

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DECLARATION

Candidate's Declaration

I, Ruth Otison Asante, hereby declare that this thesis is the result of my own original work and that no part of it has been presented for another certificate in this University or elsewhere. All references are duly recognized in the work.

Candidates Signature: ………………….……………

Date: ……………….…………………….……………...

Supervisor's Declaration

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

Supervisor's Name:…………………….……………………..

Supervisor's Signature: ……………………….….………

Date: ……………….…………………………………….……...

DEDICATION

This thesis is dedicated to my father and mother including all my Siblings for their unimaginable support. Additionally, I dedicate this book to my friend Lincoln who has been of help to me throughout this research work.

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ABSTRACT

This research sought to investigate the availability and utilisation of biology laboratory facilities by teachers in selected schools in the Central Region of Ghana. This study was carried out in the Category C Senior High Schools and the instruments used for data collections were questionnaire and Biology Laboratory Facility Checklist. All the forty (40) Category C Schools in the region were used. Three biology teachers from each school, and therefore giving a total of 120 respondents were sampled using purposive sampling technique. Coding schemes were developed to organise the data into meaningful categories. The categorised data were converted into frequency counts and simple percentages, and used to answer the research questions addressed in the study. The study found out that because of the work load on the teachers, they find it very difficult to teach and conduct regular laboratory exercises with their students. Also, lack of adequate laboratory equipment and materials is a major contributing factor to teachers' reluctance in conducting laboratory exercises since the government is finding it difficult to fund science laboratories in schools and teachers are likewise refusing to improvise. Lack of teachers' motivation is also a factor that allows teachers refuse to conduct laboratory exercises. It is therefore recommended that enough laboratory materials should be provided in various schools and also teachers should be motivated to ensure effective science practical work.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter deals with a brief discussion of the background to the study. It also encompasses the statement of the problem, purpose of the study and research questions. This chapter also captures the educational significance of the study, limitations and delimitations as well as organization of the study.

1.1 Background to the Study

Science is doing and involves regular hands–on practical work for learners to develop scientific literacy to face global challenges. Aleyideino (2000) opined that sound science education is accepted worldwide as bedrock of human development and progress, and also mentioned that no educational system can rise above the quality of its teachers, and no nation can rise above the level of its teaching staff. For science teachers to play their roles in teaching science, laboratory facilities must be available and must be used appropriately to improve the performance of students. Science education emphasises the teaching of science process and principle (Okafor, 2014; NPE, 2004). This will lead to fundamental and applied research in science at all levels of education. When laboratory facilities are appropriately utilised, they bring about more effectiveness in teaching and learning process, but this depends on teachers' ability to use such facilities effectively (Ughamadu, 1992).

Laboratory is a focal point for all scientific activities. It is usually equipped with tools that facilitate effective teaching and learning of science. Science is experimental in nature and the laboratory helps to enhance scientific knowledge through the process of science (observing, classifying, measuring and interaction with objects and events of scientific interest). Abdullahi (1982), emphasizes that science is not science unless it is accompanied by laboratory exercises i.e., putting theories into practice. Laboratory provides ideal setting for skill development, discovery learning, inquiry and problem-solving activities. Since science is experimental in nature, any course in science should reflect this by introducing laboratory work. This is because, it is in the laboratory that learners learn science through precise measurement, accurate observation and clarity in Communication (Muhammad, 2010). Laboratory work is a range of activities from true experimental investigation to confirmatory exercises and skill acquisition. Laboratory work is used to describe the practical activities which students undertake using various specimen and equipment in biology laboratory. The word "practical" can include other experimental activities conducted in the laboratory by students. Laboratory work is an established part of biology at all levels of education. The original reasons for its development lay in the need to produce skilled technicians for the industry and highly competent workers for research laboratories (Morrell, 1972). There is need to prepare students practically in the laboratory as well as develop some follow-up activities. These may enrich and enhance the whole laboratory experience and enable it to contribute more effectively to the overall learning of students in biology. It would be rare to find out any science course in any institution of education without a substantial component of laboratory activity. However, it is taken for granted that experimental work is a fundamental part of any science course and this is especially true for biology (Bonah, 2015) at the Senior High Schools in Ghana.

In the study of Biology as an integral branch of science, the facilities and equipment which students were exposed to remain crucial to the achievement made by them. The facilities and equipment here referred to infrastructures, manpower and laboratory equipment, all of which make learning fruitful and rewarding. For the past three decades, there has been tremendous increase in the number of students' enrolment in biology when compared to other science subjects (Okafor, 2014; Milgwa, 2000). This is because Biology is seen to be directly relevant to students' everyday life. On the other hand, it could be observed that students' performance in West African Senior Certificate Examination (WASCE) have constantly been poor. This poor performance has been attributed to students' inability to tackle biology practical questions (Musah & Umar, 2017).

Very frequently, it is asserted that biology is a practical subject and this is assumed, somewhat naively to offer adequate justification for the presence of laboratory work. Thus, the development of experimental skills among the students is often a suggested justification. Laboratory classes are where biology students acquire and practice key manipulative and process skills while learning to move concepts from an abstract into a concrete setting (O' Brien & Cameron, 2008). Thus, the teaching and learning of biology is a practical process which requires the use of laboratory and equipment, to enable learners come face-to-face with the teacher through the proper use of laboratory equipment, in order to make the lesson effective. When laboratory exercise is used, the abstract concepts become clearer to students, the lesson become interesting and meaningful at the same time and students retain what they have learnt (Anene, 2002). These influence student's academic performance positively (Anene, 2002).

One of the main reasons to question the place of laboratory in science teaching is that, laboratory programs are very expansive in terms of facilities and material resources, but also, more importantly in terms of staff-time (Carnduff & Reid, 2003).

West African Examinations Council (WAEC), being the highest examination body for Senior high school students in Ghana recommended that the teaching of all science subjects listed in their syllabi should be practical based (WAEC, 2018). This perhaps is to demonstrate the importance they attached to practical work in science. Biology laboratory gives students an opportunity to handle equipment and materials, to learn about safety procedures, to master specific techniques, to measure accurately and to observe carefully. However, making biology real and exposing ideas to empirical test is of great importance. Skills of observation, deduction and interpretation are also very important. In addition, there are many other important practical skills to be developed such as team-work, reporting, presenting and, developing ways to solve practical problems. Many school courses seek to develop some of these outcomes to help students learn science through the wise use of properly designed and utilise school laboratories for students to think scientifically. No matter how good a student is, without learning materials and effective methodology of teaching, his teacher may eventually lead him to low performance in biology.

Provision of laboratory facilities and relevant equipment is a necessary, but not sufficient condition for successful science teaching. The researcher is fully aware of other variables that could influence students' academic performance, like teacher's qualification, effectiveness, interest, leadership style etc. Towards the end of the twentieth century, more sophisticated alternatives had been introduced to facilitate effective learning in school laboratories. These include pre-laboratory experiences, films, video experiments, computer-based pre-laboratories, post-laboratory exercises and computer simulations which can assist the students to improve their performance in biology (Carnduff & Reid, 2003). Science laboratory requires competent personnel which include the laboratory technologists/technicians/assistant etc. for the management and organization of laboratory effectively. According to Sirajo (2014), the functions of laboratory technologists/attendants are as follows:

1. Keeping benches and laboratory clean and tidy: cleaning and drying glass-ware, cleaning out the sink and drainage systems, and emptying main waste boxes daily.
2. Drafting orders for equipment, chemicals and apparatus; Checking supplies as they arrive.
3. Oiling benches with linseed oil and turpentine or polishing benches
4. Preparation of solutions that may be needed in Biology practical
5. Setting up apparatus for demonstration and class experiments.
6. Replacing loosed or damaged levels on shelves, cardboards, and bottles and covering levels with burnish or wax.
7. Keeping of apparatus and materials in their correct places, periodic cleaning of metal stands, balance-fans, tangs, painting of retort etc.
8. Keeping the first aid box replenished and keeping record of accidents and treatment.
9. Assisting with visual aid preparation such as charts, diagrams etc and projection of film strips of films
10. Looking after plants and the animals in the laboratory.
11. Ensuring all Bunsen turners are turned out, electricity and gas turned off and water tap left dropping.

1.2 Statement of the Problem

In Ghana Biology practical covers 40% of the total score of the West African Senior Certificate Examination, but students can hardly conduct these practical because they lack the basis and confidence to conduct such practical; and this affects their performance in the West African Senior Certificate Examination (Wussah, 2019). In a study conducted in Ghana by Opong (2014) on Biology teacher's perception of the utilisation of material resources as a way forward for effective Biology education using descriptive design brought to light that material resources in Biology are rarely available in Secondary Schools and the available ones were rarely utilised. Science teachers do not always find it convenient to make laboratory work as the centre of their instruction. Also, the conditions under which many teachers operate does not engender enthusiasm to use laboratory exercise in teaching biology, even where material and equipment are available, the workload and class size may be discouraging. Likewise, over decades now science students in some senior high schools in the central region of Ghana usually fail in the practical section of biology during their final examination and rather pass the theory aspect. Therefore, the main thrust of this study is to assess the available resources and their utilisation by teachers and make suggestions on how to solve these problems to improve the students' performance in Biology.

1.3 Purpose of the Study

The study sought to investigate the availability and utilisation of biology laboratory facilities by teachers in some selected senior high schools in the Central Region of Ghana.

1.4 Objectives of the Study

Specifically, the study sought to:

1. asses the availability of biology laboratory resources in some selected SHS in the Central Region
2. determine the extent of utilisation of the available biology laboratory facilities by teachers for teaching and learning biology in Senior High Schools in the Central Region

3. determine the level of exposure of senior high school students to biology laboratory exercises in Central Region
4. examine the factors that affect the effective use of laboratory resources in teaching and learning in Central Region

1.5 Research Questions

The following research questions were raised to guide the study:

1. What are the available biology laboratory facilities for use by teachers in the teaching and learning process in the central region?
2. To what extend are laboratory resources being used by teachers in teaching practical lessons in biology in the central region?
3. What is the level of exposure of senior high school students to biology laboratory exercises in Central Region?
4. What are the factors that affect the effective use of laboratory resources in teaching Biology to senior high school students in Central Region?

1.6 Significance of the Study

The findings of this research work will be beneficial to the state and to the nation at large in the following ways:

It will provide administrators, headmasters and science teachers with necessary information on the importance of laboratory facilities in the teaching and learning of Biology in the central region. This will also enhance utilisation of laboratory facilities by the teachers. Furthermore, the findings would improve the performance of the students in Biology through the utilisation of laboratory facilities and also upgrade them for further studies in biology and other sciences.

In addition, the outcome of the research will develop both scientific process and attitudes in the students. It will also help curriculum planners to lay more emphases on the need for availability of laboratory facilities and equipment as major tools in learning science in order to enhance teaching and learning process in this country. It will also stimulate the curriculum planners and administrators of schools to organise seminars and workshops for the teachers in order to expose or widen their knowledge on how to utilise and manipulate the available laboratory facilities and equipment instead of allowing insects and cobwebs to be in charge. It will also encourage students to practice science through science exhibition, projects and competition among different levels.

In addition, the outcome of the research would encourage the Inspectorate Division of Ministry of Education to be up and doing in checking how the laboratory facilities are utilised by the teachers and their students so as to advise the government on the need to build more school laboratories and provide more laboratory equipment and materials to cater for the large class syndrome in the Senior High Schools in the central region. This will also discourage teaching and learning by mere regurgitation of facts and encourage experimentation and exploration which are activity based.

Finally, the findings of this study will also serve as a resource material to researchers who may be interested in the area. Additionally, it will provide the framework for researchers to build on.

1.7 Delimitations of the Study

The study covered all the Category C, single sex and co-educational public senior high schools in the Central Region that offer General Science. It is delimited to Biology Laboratories and biology teachers in the Category C Senior High Schools. The Central

Region has three categories of schools, thus A, B and C. The Category A and B schools were not used for the study because they have well equipped biology laboratories as compared to the Category C schools. The study only focuses on laboratory facilities/ equipment and students' academic performance.

1.8 Limitations of the Study

The traditional school practices such as inter-house, inter-school football, athletics games and cultural activities interrupted the researcher′s work schedule and limited the amount of data that were collected, and extended the time for data collection. The truant behaviour of some students made the collection of data to fluctuate. Also, the sample size is small so the results obtained cannot be applied to a larger population of teachers.

1.9 Operational Definition of Key Terms

The relevant terms below were operationally defined relative to their usage in this study.

Academic Performance: This is regarded as the display of knowledge attained or skills, such achievements which are indicated by test scores or by marks assigned by teachers. It is the school evaluation of students' classroom work as quantified on the basis of marks or grades.

Utilisation: The act of using something to achieve a purpose.

Instructional Material: What the teacher uses to make the lesson more interesting and understandable.

Availability: Something that is ready to be used at any given time.

1.10 Organisation of the Study

The report of this study is presented in five chapters. The first chapter deals with the background to the study, statement of the problem, purpose of the study, objectives of the study, research questions, significance of the study, scope of the study and limitations of the study and organisation of the chapters of the study.

The review of existing relevant literature is presented in chapter two. Chapter three discusses the methodology which comprises the design of the study, study area, populations, sample size and sampling technique, instruments and data collection procedure as well as the method of data analysis. Chapter four presents the results and the discussions of the findings. Lastly, the summary of the main findings, conclusions, recommendations and suggestions have been presented in the fifth chapter.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter captures the views of various researchers who have worked in this field. This section therefore considers literature under the following themes;

- Teaching and Learning
- Science Teaching Methods
- Influence of Biology Teaching Methods on Students' Motivation
- Origin of Experimental Science
- Definition and Historical Perspective of Science Laboratory
- Strategies for Effective Use of Laboratory Experiences
- Effectiveness of Practical Work
- Materials for Biology Practical Work
- Importance of Laboratory work in Senior High Schools
- Cons of Practical Work
- Availability of Functional Laboratory Facilities
- Effective Design of Laboratory Learning Experiences
- Management of Biology Laboratory Facilities by Teachers
- Safety in Laboratory
- Problems Facing the Effective Use of Laboratory in Teaching Science
- Improvisation of Laboratory Equipment
- Academic Performance of Students in Biology
- Overview of Studies on Laboratory Facilities Utilisation and Students' Performance

2.1 Teaching and Learning

The biology curriculum has an in-built flexibility to cater for the interest, 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 as investigation, discussions, demonstrations, practical work, project, and studies, model-making, case- studies, oral report, assignments, debates, information search and role play (Adjei-Kankam & Adjei & Asante & Nkansah, 2018). Practical work and investigations are essential components of the biology curriculum. They enable students to gain personal experience of biological knowledge through hands on activities and to enhance the skills and thinking processes associated with the practice of science. Participation in these activities encourage students to bring scientific thinking to the processes of problem solving, decision making and evaluation of evidence.

Engaging in scientific investigation enables students to gain an understanding of the nature of science and the limitations of scientific inquiry. Presently, practical activities at all levels of education are to be provided through the use of either the conventional approach or computer assisted approach. The conventional approach includes the use of standard laboratories, science kits, teacher demonstrations and other activities (Adjei-Kankam et al, 2018). Thus, there are procedures for organising practical work in schools which tutors are expected to be following. But as to whether or not all tutors have been paying heed to such procedures remained an interesting phenomenon to investigate. The current approach to biology teaching in most colleges of education is most often based on classroom and laboratory work which are intended to meet examination requirements.

Unfortunately, the examination- driven mode of biology teaching has limited the biological (science) and technological scope and perspects of the students. Not only does the approach tend to make the study of biology uninteresting, boring and not enjoyable but also, students find it difficult to relate the theoretical knowledge with the practical realities of life and the use of manipulative skills.

The process skills or approaches reveal some of the processes of science. These include observing and describing, classifying and organising, measuring and charting, communicating and understanding communication with peers, predicting and inferring hypothesising, hypotheses testing, identifying and controlling variables, interpreting data and constructing instruments (Agboala, 1984). According to Agboala all these processes can be achieved through group work during practical activities. He is also of the view that some of the scientific human abilities important in the process skills domain are visualizing (thus producing mental images), combining objects and ideas in new ways as well as offering explanations for objects and events encountered. Others are questioning, producing alternate or visual uses of objects, solving problems and puzzles, designing devices and machines, producing usual ideas and devising tests for explanations created.

Development of the above domain will not be achieved if the practical work is not effectively used during biology lessons. Attitudinal domains such as values, human feelings and decision-making skills is also important enough to be addressed at the colleges of education. Practical work done in groups, enables students to develop attitudes such as positive attitudes towards biology and science in general and science tutors. It also affords the students the opportunity to develop sensitivity and respect for others, express personal feelings in a constructive manner and to make decision about personal values and social environmental issues. In application and connections domain, Adedapo (1976) observed that science is related to everything, especially subjects such as mathematics, social science, vocational subjects and the humanities. Practical work done by students during biology lessons enable them to develop scientific concepts in everyday life experience and to apply learned biology concept and skills to everyday social problems. Not only that, practical work enables students to understand scientific and technological principles involved in household technological devices and to evaluate the mass media report of scientific development.

2.2 Science Teaching Methods

According to Ayeni (2011), teaching is a continuous process that involves bringing about desirable changes in learners so as to achieve specific outcomes through the use of appropriate methods. Quite remarkably, regular poor academic performance by majority of students is fundamentally linked to the application of ineffective teaching methods to impact knowledge to learners (Adunola, 2011). Research on the effectiveness of teaching methods shows that the quality of teaching is normally reflected by the achievements of learners. Adunola (2011) indicated that in order to bring desirable changes in students, teaching methods used by educators should be best for the subject matter. Furthermore, Bharadwaj and Pal (2011) suggested that teaching methods work effectively mainly if they suit learners' needs. As such, alignment of teaching methods with learners' needs and preferred learning influence students' academic attainments (Zeeb, 2004). Hence appropriate teaching strategies elicit desirable learning outcomes.

2.3 Methods Used in Teaching Biology and Students' Motivation

There are many methods of teaching employed in the teaching of biology at the senior high school level. No single method can be said to be sufficient to be used in the teaching and learning of biology at the senior high school level. There is, therefore, the need to search for more effective strategies that are likely to improve achievement in biology. The benefits of co- operative learning for science students are well documented (Springer & Stanne, & Donovan 1999; Lord, 2001). Cooperative learning works, because it is active, student centered and social. A cooperative learning activity might involve reading, writing, planning experiments, designing questions, or solving problems. This multi-layered approach toward student interaction with the content improves understanding and retention. Since, cooperative learning shifts emphasis from the instructor to the students, the latter have opportunities to build social support networks and to learn and practice many social skills, such as leadership, communication, inquiry and respect for diversity (Lord, 2001).

The development of social relationships and skills helps students to build confidence as learners and to build trust in their teammates. This leads to improve attitudes toward the subject and often to the retention of underrepresented populations in science programmes. Peer tutoring is a type of cooperative learning/instructional strategy. It is a personalized system of instruction which is learner rather than teacher-oriented. Studies have shown that this instructional strategy benefits both the students being tutored and the tutor, although the tutor is associated with greater cognitive gains than the student being taught (lord, 2001). It has also been observed that when biology lessons are done in groups, students are allowed to make valuable decisions which together lead to a satisfactory accomplishment. Group work during practical is a pervasive and an influential feature of the classroom ecosystem, which must be encouraged in the teaching and learning of biology in our schools.

Practical work, which is 'hands-on' activities, is an essential component when it comes to the study of the natural sciences, such as Biology, Chemistry and Physics. It is based on the assumption that learning by doing is best for acquisition of knowledge, and also give insight into the scientific attitudes and skills development. According to Freedman (1997), the motivation to learn biology does not only depend on the interests that the students bring to school. It can also be the result of certain learning situations; among which we find laboratory work.

Many studies provide evidence supporting the idea that students' interest is enhanced by their involvement in real-world science projects and investigations (Barron et al., 1998; Krajcik et al., 1998). Carrying out hands-on practical activities can also be engaging to students (Freedman, 1997). Although studies suggest that many students lose interest in science class after age 11 because they find school science boring (Hadden & Johnstone, 1983; Simon, 2000; Yager & Penick, 1986), the aspect of science that students consistently report as most appealing is hands-on laboratory work. Biology among the sciences has been given a special recognition by most educators not only because of its educational values, but also its close relation to humans as living organisms, the peculiar field of experimentation and interrelationship with other career sciences. It is found to be the leading way to profession such as Medicine, Pharmacy, Agriculture, Dentistry, and many others. But in Senior High School, science students do not select from these subjects

There is also enough evidence that most students fail in biology at the Senior High School because they do not perform well in paper 2, which is a practical paper. This paper tests skills in drawing, identification and classification, analysis of some processes and interpretation of biology data. Biology is a unique discipline where experiments with living organisms do take place both in the laboratory and in the field. However, increasing use of virtual environments instead of practical investigations in biology has recently been documented (Tranter, 2004). Biology is one of the elective subjects in the Key Learning Area (KLA) of science education. Its curriculum provides a range of balanced learning experiences through which students are expected to develop the necessary scientific skills and processes, values and attitudes as well as knowledge and understanding embedded in the life and living strands and other strands of science education for personal development and for contributing towards building a scientific and technological world.

2.4 The Origin of Experiential Science

The use of laboratory method in science teaching originated from the ideas of early scientists. The 17th century is very significant in this respect Mendelson (1982), characterised the century as the century of "the scientific revolution". This characterisation is so because according to Westfall (1971) it was in the 17th century that the experimental methods became a widely employed tool of scientific investigation. Taylor (1963) claimed that the idea of experimental science began to have influence in about 1590 when scientists started basing their work on deliberately contrived experiments. According to him, Galileo Galilei (1564-1643) was the first to employ the scientific method in the fullness in physics and astronomy.

However, it was in the 17th century that scientists paid greatest attention to the scientific method that led to a revolution in science. The sheer number of persons that paid attention to methods then indicated the need for an acceptable method of conducting experiment in science. Francis Bacon (1561-1626) was perhaps the first in the 17th century to formulate a series of steps to account for the scientific methods in his book, Novum Organum (Taylor, 1963). The book was a reaction to Aristotle's treatise in logic referred to as Organum. Bacon based his method on the inductive method of objective observation and experimentation without any preconceptions.

Westfall (1971), credited Robert Boyle with perhaps the best statement of the experimental method that focused on "the activity of investigation that distinguishes the experimental method of modern science from logic". The emphasis on method during this period paid off with the several discoveries and inventions in the 17th century and beyond, thereby giving the impression that science is synonymous with its method.

2.5 Definition of Laboratory Experiences

Science teaching especially in senior high schools in Ghana is mostly conducted within a special accommodation called the school laboratory. Laboratory has been described as a room or a building specially built for teaching by demonstration of theoretical phenomenon into practical terms. Farombi (1998) in Yara (2010) argued the saying that seeing is believing is the effect of using laboratories in the teaching and learning of science and other science related disciplines as students tend to understand and recall what they see more than what they hear. Laboratory is very important and essential to the teaching of science and success of any science course is much dependent on the laboratory provision made for it. Lending credence to this statement, Ogunniyi (1982) in Yara (2010) said that there is a general consensus among science educators that laboratory occupies a central position in science instruction. It could be conceptualized as a place, where theoretical work is practicalised and practical in any learning experiences involve students in activities such as observing, counting, measuring, experimenting, recording and carrying out fieldwork. These activities could not be easily carried out, where the laboratory is not well equipped. There is usually a strong move to emphasise the dependence of science teaching on the existence of a well-equipped science laboratory. Below are definitions of laboratory from different authors.

Hegarty-Hazel (1990) defined laboratory work as: a form of practical work taking place in a purposely assigned environment where students engage in planned learning experiences and interact with materials to observe and understand phenomena (Some forms of practical work such as field trips are thus excluded). Lunetta defined laboratories as "experiences in school settings in which students interact with materials to observe and understand the natural world" (Lunetta, 1998). These definitions include only students' direct interactions with natural phenomena. However, both such direct interactions and also student interactions with data drawn from the material world are all part of laboratory experiences. In addition, these earlier definitions confine laboratory experiences to schools or other "purposely assigned environments," but students observe and manipulate natural phenomena in a variety of settings, including science museums and science centers, school gardens, local streams, or nearby geological formations.

Muhammad (2010), defined science laboratory as an instructional facility that helps pupils to learn what science is and how scientists work. There are several locations in and around the school which could serve as means of helping students learn science. In its broadest sense, such locations are considered to be laboratory facilities that provide meaningful science learning experiences. These locations include: A nearby school garden, a carpenter/blacksmith/mechanic workshop, pond, railway station, hospitals etc. These locations provide direct science learning experiences to the students by bringing them face to face with the concrete objects and happenings, these locations are more suitable for learning science. Based on Mohammad's (2010) definition, two types of laboratories can be identified:

1. Indoor laboratory: Suitable place specifically designed, organised and managed for scientific investigation.
2. Outdoor laboratory: Suitable place used for scientific investigations outside the classroom e.g., Farm, river, stream, mechanic workshop etc.

Rapid developments in science, technology, and cognitive research have made the traditional definition of science laboratories as rooms in which students use special equipment to carry out well-defined procedures obsolete (Research Counsel, 2006). As a result of this, the Committee for Investigations in High School Science gathered information on a wide variety of approaches to laboratory education, arriving at the term "laboratory experiences" to describe teaching and learning that may take place in a laboratory room or in other settings (Research Counsel, 2006).

Laboratory experiences provide opportunities for students to interact directly with the material world (or with data drawn from the material world), using the tools, data collection techniques, models, and theories of science (Research Council, 2006)

This definition includes the following student activities:

- Physical manipulation of the real-world substances or systems under investigation. This may include such activities as chemistry experiments, plant or animal dissections in biology, and investigation of rocks or minerals for identification in earth science.
- Interaction with simulations. Physical models have been used throughout the history of science teaching (Research Counsel, 2006). Today, students can work with computerised models, or simulations, representing aspects of natural

phenomena that cannot be observed directly, because they are very large, very small, very slow, very fast, or very complex (Research Counsel, 2006). Using simulations, students may model the interaction of molecules in chemistry or manipulate models of cells, animal or plant systems, wave motion, weather patterns, or geological formations.

- Interaction with data drawn from the real world. Students may interact with real-world data that are obtained and represented in a variety of forms. For example, they may study photographs to examine characteristics of the moon or other heavenly bodies or analyse emission and absorption spectra in the light from stars. Data may be incorporated in films, DVDs, computer programs, or other formats.
- Access to large databases. In many fields of science, researchers have arranged for empirical data to be normalised and aggregated—for example, genome databases, astronomy image collections, databases of climatic events over long time periods, biological field observations. With the help of the Internet, some students sitting in science class can now access these authentic and timely scientific data. Students can manipulate and analyse these data drawn from the real world in new forms of laboratory experiences (Bell & Smetana, 2008).

It has become increasingly clear that it is not realistic to expect students to arrive at accepted scientific concepts and ideas by simply experiencing some aspects of scientific research (Millar, 2004). Recognising these limitations, it is prudent that laboratory experiences at least partially reflect the range of activities involved in real scientific research. Providing students with opportunities to participate in a range of scientific activities represents a step toward achieving the learning goals of laboratories

Historians and philosophers of science now recognise that the well-ordered scientific method taught in many high school classes does not exist. Scientists' empirical research in the laboratory or the field is one part of a larger process that may include reading and attending conferences to stay abreast of current developments in the discipline and to present work in progress. As Schwab (1964) recognized, the "structure" of current theories and concepts in a discipline act as a guide to further empirical research. The work of scientists may include formulating research questions, generating alternative hypotheses, designing and conducting investigations, and building and revising models to explain the results of their investigations. The process of evaluating and revising models may generate new questions and new investigations. Recent studies of science indicate that scientists' interactions with their peers, particularly their response to questions from other scientists, as well as their use of analogies in formulating hypotheses and solving problems, and their responses to unexplained results, all influence their success in making discoveries (Research Counsel, 2006). Some scientists concentrate their efforts on developing theory, reading, or conducting thought experiments, while others specialize in direct interactions with the material world (Bell, 2005).

Student laboratory experiences that reflect these aspects of the work of scientists would include learning about the most current concepts and theories through reading or class discussions; formulating questions; designing and carrying out investigations; creating and revising explanatory models; and presenting their evolving ideas and scientific arguments to others for discussion and evaluation. Currently, however, most senior high schools provide a narrow range of laboratory activities, engaging students primarily in using tools to make observations and gather data, often in order to verify established scientific knowledge. Students rarely have opportunities to formulate research questions or to build and revise explanatory models.

2.6 Strategies for Effective Use of Laboratory experiences

2.6.1 Laboratory Demonstrations

It begins by demonstrating key techniques or equipment operation or describing the location and handling of special materials. The students are gathered close to focus them on what you are doing and to ensure that everyone can see and hear. Again, they are focused on the key terms and functions that are in the procedures, and use the demonstration to generate excitement about the laboratory. The teacher should not attempt to demonstrate equipment he has not practiced using. If the teacher made mistake during his demonstration, it is instructionally important to describe how he made the mistake, it is good to familiarise him with the equipment operation prior to the demonstration. (Allen, et al., 2009).

2.6.2 Laboratory Instruction

A good science teacher should maintain an active role and consistent pace of interaction throughout the laboratory period so that students learn what to expect from him as an instructor. He should include several moments of whole class instruction at key points in the laboratory. When the teacher is asked the same question three times, or three groups have the same problem, it is likely that other groups will have the same question or problem as well. He should gain everyone's attention and use this moment to provide targeted "just in time" instruction or feedback for everyone. During the class, he should move around the room to make himself accessible to students, focusing equal time on groups that ask and those that don't ask for help. He should be aware of the progress of all student teams, address students by name whenever he gets the chance, and listen to what is being said in groups to help you anticipate and diagnose instructional problems. He should not assume that since a group is quiet, they know what they are doing. He can diagnose a laboratory problem early by observing what is being done or said in seemingly on-track groups. It is always useful, and never unappreciated, for a teacher to approach a group to find out if they are on the right track. (Allen, et al., 2009).

The use of the laboratory method in teaching science has become a dogma among science educators and teachers. On one hand, they extoll the importance of the use of the laboratory method in science teaching while on the other hand, they only pay "lip service" to its use in practice. Science teachers do not usually find it convenient to make laboratory work the centre of their instruction. They usually complain of lack of materials and equipment to carry out practical work. At the same time, it is possible that some of these materials and equipment may be locked up in the school laboratory store without teachers being aware of their existence. The conditions under which many the materials function do not engender any enthusiasm to use the laboratory method of teaching science even where they know that these materials and equipment are available. Class size in urban schools is getting larger and this does not usually encourage teachers to use the laboratory method to teach science. In some cases, teachers are not motivated enough. As such, these under motivated science teachers cannot reasonably be expected to give off their best to their students. Higher institutions in Ghana charged with the responsibility of training science teachers at all levels, are increasingly turning out teachers without requisite laboratory experience. A common reason usually given is shortage of laboratory facilities. Such trained science teachers usually lack the necessary confidence to conduct practical classes with their students. The condition of the national economy continues to deteriorate without any sign of improvement in sight (Abimbola, 1996).

In addition, most of laboratory classroom are not equipped with work tables that have sinks, a water supply, and natural gas and electrical outlets available in sufficient quantity to support a laboratory-based science course. There is no enough allocation of funds to provide opportunities to learn in an inquiry-based curriculum. There are no approved guidelines for the safe use, maintenance storage and disposal of laboratory materials (Abimbola & Danmole, 1995).

2.7 Effectiveness of Practical Work

Several studies examining the role of practical work on student attainment investigated many aspects of the quality of the practical work, such as the design of the task given in terms of encouraging students to make links between the theoretical and practical sides.

In a study done on a sample of 25 science lessons involving practical work in English secondary schools, the results showed that the practical work supported the direction of the lesson in that it kept students focused on tasks and doing the hands-on work. However, practical work was proven less effective in getting those students to make a connection between concept and application in the lab and reflect on their collected data (Abrahams & Millar, 2008). The study found that there was insufficient proof that linking concepts to observables is taken into consideration by the people who design these activities for the science lessons.

Millar (2004) proposes that students' minds should be stimulated prior to starting any practical work by providing them with some background information on what it is they are investigating. Also, the task design should direct students' efforts to make links between the two domains of knowledge. Consequently, science teachers should be trained based on the most recent research studies to amend their practices and put forth more time and effort to reflect on linking scientific concepts with the natural world (Jokiranta, 2014).

However, one should keep in mind that the feedback from teachers of laboratory work is a vital source of information about its value. In previous studies, they mentioned that laboratory work is vital for studying sciences but there are certain problems they faced such as: lack of materials needed for the required experiments, insufficient information for carrying out the experiment, insufficient techniques followed during the experiment, lack of information about the glassware and the chemicals that are needed for the experiment, lack of information about safety rules, lack of information about the steps that should be followed to avoid any accident during the experiment and finally what should be done in case of an accident during the experiment (Aydogdu, 2015; Boyuk, Demir & Erol, 2010). Wussah (2019) quoted West African Examination Council (WAEC) chief examiner's report 2019 which shows that despite the fact that there are improvements in the subject; students' performance in Biology is poor due to their inadequate exposure to practical work and their non-acquisition of relevant skills. Research works have shown that Biology enjoys much better patronage by the students than Chemistry and Physics. However, the trends in the West African Senior Secondary Examination (WASSCE) show that the failure rate is highest in Biology when compared to Chemistry and Physics.

Oyedokun (2002) opined that poor result in Biology might be due to the fact that almost every student with or without ability is enrolled for the subject. It has been observed that poor performance in sciences is caused by poor quality of science teachers, overcrowded classrooms and lack of suitable and adequate science equipment (Yusuf & Afolabi, 2010). According to them, students perform poorly in Biology because Biology classes are usually too large and heterogeneous in terms of ability level. In addition to that, the laboratories are ill equipped and the syllabus is overloaded (Ahmed, 2008). On the other hand, lack of adequate facilities such as textbooks, ill-equipped classrooms, laboratories, workshops and libraries are among the probable causes of students' poor performance in examination (Olubor, 1998).

According to Oyebola, (2008) low level students' academic performance is related to the decline in the availability of teaching resources in our schools. Ugbaja (2018) observed that over the years the performance of the students has not been impressive as evidenced from the School Certificate Examination results of the West African Examination Council (WAEC). Ihuarulam (2008) was of the opinion that the poor performances in the biology and in other Science subjects have been attributed to quality of teachers and available learning resources. Oyebola (2008) observed that certain factors that influence academic performances are poor physical environment, shortage of personnel, learning facilities and poor quality of teaching. She identified other factors that influenced poor academic performance of students as overcrowded classrooms, lack of laboratories, inadequate instructional materials and poor library facilities. Ugbaja (2018) confirms that there is a sharp fall in students' performance in Biology. The reason he advanced for this sharp fall was that student's performance in Biology is due to poor qualities of some laboratories or teachers' avoidance of teaching certain topics in the syllabus.

Ihejirika (2019) opined that some studies have demonstrated that students' academic performance in WASSCE Biology and other Science subject examination since eighties have remained poor. Among the reasons she listed for the poor performance are poor use of Biology terminology, poor diagrams, careless drawing and labeling, incompetence and laziness on the part of the teachers. Ihejirika (2019) reported that candidates' performance was worst in Biology with 49.1% passes, compared with

55.4% passes in Chemistry and 62.5% passes in Physics. While Hills (2009) in Ihejirika (2019) attributed poor academic performance of students in Biology to poor state in which science is being taught in schools. “Chalk and talk” method has been the most widely used science teaching due to poor quality laboratory, large class size and much work load on the teachers. Ihejirika, (2019) identified the following factors for the poor performance of students in Biology as:

- Almost every student with or without ability is enrolled for the subject.
- Poor quality of science teachers.
- Overcrowded classroom.
- Lack of suitable and adequate Science equipment.
- Over-loaded syllabus.
- Poor and careless diagrams.
- Poor labelling and poor use of biological terminology.

There is the need to investigate into the utilisation of the laboratory facilities. Qualification of Biology Teachers in Secondary Schools: A lot of blame on the poor performance of the students in Science (Biology) has been put on their science teachers because most of the Science teachers are not qualified, not well trained, not motivated and also given less tools to work or teach with. According to Olayiwola (2005) the scarcely equipped laboratories in most tertiary institutions may not be adequate to produce the needed science teachers for effective Science teaching at Senior High Schools level. He added that this problem often results in teaching Science courses theoretically, resulting in poor students’ acquisition of practical skills.

Oyebola (2008) was of the view that teachers are responsible for the translation and implementation of educational policies, curriculum, instructional material package and assessments of school outcomes. He also said that no curriculum can achieve the desired result unless the teachers who implement it are appropriately trained and properly initiated into its development. According to Doka (2008) the state of laboratory with respect to items, quality and quantity of the laboratory facilities affect the teaching of science education and the quality of the teachers produced.

2.8 Materials for Biology Practical Work

There are many aspects to determine the success of learning process. One of the aspects is learning environments. A study conducted by Fraser (2002) showed that learning environments do not only have the positive correlation with the student's outcomes, motivations, and attitudes, but also teachers' motivation. Frasers study on learning environments focused on student's outcomes, students' and teachers' perceptions, and evaluation of the strategies. According to him, the factor that contributes most to self-evaluation is the learning environment. Such an environment allows students to synthesise, analyse, explore, criticise and create their own concepts about the learning material.

A study conducted by Onyegegbu (2001) revealed that secondary school's biology students in Nigeria, approach biology laboratory activities with mixed emotions. For some, these activities are windows on the world of biology, allowing them to gain experience with the techniques, concepts and emotions that go with real research. For some others, practical lessons in biology laboratory are exercises in preordination, tedious derivation of answers that are already known to questions that do not seem important. According to him, one of the major problems that he experiences as a biology teacher in the secondary school biology laboratory, is that, teachers feel that demonstrating or carrying out activities in the laboratory amount to inviting trouble, and tedious. Often this turns out to be major cause of their indifference to practical work. Moreover, the topics are so restricted to examination scheduled curriculum that teachers must comply to if their students are to pass their external examination.

However, on the part of biology tutors, it is rather disturbing to note the apathy or indifference, with which biology practical activities are conducted in the biology laboratory. Practical biology activities if done in the laboratories are done with the mundane, unimaginative manner (Onyegegbu, 2001). These endings in the researcher's opinion are not different from what pertains in the colleges of education in Ghana. The classroom, laboratory and the school environment can be made conducive to teaching and learning of biology through improvisation of materials by teachers when standard laboratory equipment are not available. Availability of teaching and learning materials for biology practical work plays an important role in the learning of biology.

Abdurahman (2009) contended that the availability of physical and material resources is very significant for the success of any worthwhile educational endeavor. This researcher agreed that, availability of adequate school buildings, number of classrooms, chairs, desks and laboratories for science teaching are imperative for the attainment of any educational objectives. In his study, Abdulrahman (2009) found a significant relationship between teachers, facilities and schools' academic performance. In his view, Abdul Rahman noted that teachers are more important than the equipment of the laboratory for the understanding of the science concepts. Laboratory equipment may remain teaching materials for the improved performance without teachers. Abrahams & Millar (2008) found out that when physical and material resources are provided to meet the needs of the school system, students will also learn at their own pace. The net effect is that it increases the overall academic performance of the students. Biology laboratory work is used here to describe the practical activities, which students undertake using specimen, chemicals and equipment.

Sotiriou, Bybee and Bogner (2017) mentioned that traditional lab work focuses solely on scientific terminology and allows students to see only what is happening during experiments; in addition, students may follow instructions written in the lab manual step by step which will not give students the chance for creativity and cannot develop their cognitive skills. If students simply follow the lab manual during experiments without connecting it to real life, then the methods will be of no value. According to Madhuri, Kantamreddi, and Goteti (2012), “the most important negation of cookbook style laboratory is it doesn't help students translate scientific outcomes into meaningful learning.” Some teachers show doubts regarding the effectiveness of practical work in teaching scientific knowledge. For example, Hodson (1991) states that: “As practiced in many schools, it (practical work) is ill-conceived, confused and unproductive. For many children, what goes on in the laboratory contributes little to their learning of science. At the root of the problem is the unthinking use of laboratory work.” Some learners show similar doubts about the effectiveness of practical work in students’ learning of science, as was found by Woolnough and Allsop (1985) and Osborne (1993). The reason for such criticisms by these learners is that practical work is ineffective for learning a concept or a theory.

According to Millar (2004), one important condition for the success of inquiry-based learning is that the learning objectives should be clear, concise and easy to follow by the learners. Solomon (1999) mentions a scenario where a student in the medical field is exposed to his first X-ray picture and cannot make sense of it. Lecture alone, without seeing an X-ray picture, made it difficult for him to comprehend the results. When finally combining both the theoretical and the practical, everything made more sense to the student. Thus, it can be concluded that in the scientific field practical and theoretical delivery are intertwined and cannot be separated. To be effective, pre-laboratory preparation needs to be more than just an encouragement for students to read their manual before coming to class: pre-laboratory exercises must be designed as carefully as the practical manual itself (Johnstone & AlShuaili, 2006). Pre-laboratory exercises are essential form of guide to instruction. There is strong evidence that students learn more deeply through guided instructions than through discovery-based learning (Kirschner, et al., 2006). Example of such activity is worksheets which have been shown to have positive effects on student performance (Nadolski, et al., 2005). It leads to transfer of knowledge and problem-solving skills and guards against students acquiring misconceptions or disorganized knowledge (Kirschner, et al., 2006). Sometimes the apparatus required by the teacher may not be available. When the alternative is to make the item or apparatus ourselves, then the idea of improvising thus comes in. To improvise in science laboratory is simply to provide or make an alternative apparatus, which we do not have in stock.

Muhammad (2010), defines improvisation as the act of using any product of similar or near similar to the actual instructional material in order to facilitate learning. i.e., creation of cheap and simple alternatives by the teacher or students and the careful selection of commonly available materials in order to made the teaching-learning process easier. It can also be view as the means of constructing or creation of cheap and simple alternatives by the teacher or students to make the teaching and learning process easier. The fact is that, in the absence of the actual instructional materials, an alternative to construct or made new one for used is what improvisation is all about. Other reasons for improvising teaching/learning material include:

i. To encourage creativity in teaching/learning situation
ii. To save cost.

Improvisation is vital in science teaching and learning, especially when materials and equipment in the laboratory are not adequate to meet the class size (Rothsak, 2013). Since experiment to be perform in the class, should be carried out by the students themselves and should take the form of "finding out" improvisation cannot be avoided by the teacher. Opong (2014), reported that the best way to teach the skills and attitude of science in the laboratory-based instruction is to give the learners an opportunity to practice these skills. These skills are not in-born but are developed and mastered through practice. It is in the laboratory that learners have the opportunity to practice science and acquire the right scientific skills and attitudes. Students who are privilege to conduct practical adequately perform better in science achievement test (Katcha, 2013).

2.9 Availability of Functional Laboratory Facilities

Laboratory facilities are the material resources that facilitate effective teaching and learning in schools. Laboratory facilities are those things which enable a skillful science teacher to achieve a level of instructional effectiveness that far exceed what is possible when they are not provided (Bonah, 2015; Jaiyeoba & Atanda, 2005; Timilehin; 2010). The problem of inadequate instructional facilities in Ghanaian schools is dated back to the beginning of formal education in Ghana and the provision of educational facilities was not given adequate and proper attention it deserved (Adesina 1990). Adesina further said the resultant effect was overcrowding of pupils in the schools leading to overstressing of available spaces and facilities. Oyetunde (2008) was of the view that the problem of lack of school facilities or inadequate school facilities is affecting all Secondary Schools.

Ahmed (2003) revealed that in most of the nation's Secondary Schools, teaching and learning take place under a most non conducive environment, lacking the basic materials and thus hindered the fulfillment of educational objectives. Lack of adequate facilities such as text books, workshops, ill equipped classrooms, laboratories and libraries are among the probable causes of student's poor performance in examination. Despite the fact that practical work is a unique source of teaching science, it is widely acknowledged that laboratory equipment is lacking in most schools (Omosewo, 2010). She also concluded from her studies that practical work was difficult to organise as a result of lack of apparatus.

Onawola (1982) reported lack of qualified teachers in addition to lack of equipment for laboratory work and also reported lack of adequate equipment most especially in established schools. Some researchers have found shortage of laboratory facilities as the cause of students' failure in science skills because their teachers were unable to conduct practical as they would like to and this always has inevitable consequences for students' learning. The shortage of laboratory facilities could have serious implication on the quality of school output (Adeyemi 2006). Onah and Ugwu (2010) revealed that the constraint to quality science education in Ghana is inadequate laboratory equipment/facilities in our schools.

According to Aderounmu, Aworanti and Kasali (2007) the strict adherence to the school time table with little or no provision for adequate qualified staff, tools, equipment, workshops and laboratories perhaps could lead to poor performance in Science, Technology, Education and Mathematics (STEM). In addition, they said that most teaching in STEM classes which are supposed to be done with charts and real-life objects are mostly done in abstract, ignoring the fact that 'seeing is believing'. Biology is an activity – based and student centered subject and cannot be effectively taught without equipment (Nwagbo, 2008). She further said lack of equipment/materials have provided excuses for Biology teachers who now neglect the practical aspect which has greater potential for developing critical thinking and objective reasoning ability in students. They resort instead to expository method of teaching which is known for promoting rote learning and hindering transfer of learning (Bonah, 2015). In order to ensure better performance from schools, there is need to provide necessary facilities (Suleiman, 1993).

Ihuarulam (2008) argued that the absolute neglect in the provision of effective teachers, enough materials and fund has worsened the quality of education as was reflected in public examination. The inadequacy of academically competent professionally sound and enduring committed school personnel, inadequacy of well-equipped laboratory/workshop are factors hindering meaningful curriculum development in science. Ogunleye (1999) said that one of the objectives of teaching science in schools is to communicate the spirit of science and to ensure that students acquire the process skills of science. This cannot be effectively achieved unless students are exposed sufficiently to practical work and laboratory experimentation. He further said that many of our secondary schools that were established over the years still remain without science laboratories; others have laboratories that are not sufficiently equipped.

According to Mohanty (2007) only 19.35% of his sampled schools had Science laboratory, 80.65% of the schools used to go without laboratory. He also said that there was no Science laboratory in any of the Junior Secondary Schools except in one private Secondary school. Audu and Oghogho (2007) said that one of the major aspects of Science Education that has been of great concern is the area of availability and effectiveness of usage of specialized Science equipment, facilities and teaching aids. They quoted Abimbola (1997) who said that in Africa, one of the most striking problems of Science Education is that of inadequate Science teaching materials. Oboh (2008) opined that teaching of Biology in most Ghanaian schools is more theoretical than practical. The usual reason given is the unavailability of materials and equipment. This is supported by Danmole and Abdullahi (1990) who emphasized the importance of improving instructional strategies through the use of teaching aids. Laboratory facilities are material resources that facilitate effective teaching and learning and also promote students' performance. The inadequacy of these facilities has been noted many years back and still persists particularly with the overcrowding classes (Oyetunde, 2008; Adesina, 1990). It was also observed that where the facilities are available, they are not usually used due to unqualified teachers and their incompetency to use the facilities. Therefore, there is the need for this study to find out the relationship between laboratory facilities and performance in Biology in the Senior High Secondary Schools.

2.10 Management of Biology Laboratory Facilities

Facility management is an integral part of overall management of school. The actualisation of goals and objective of education require the provision, utilisation and appropriate management of the facilities. Asiabaka (2010) observed that the advance in Science and Technology necessitate that the school managers should adopt modern methods of facilities management. She was of the view that modern management of facilities will improve the quality of teaching and learning of science. Based on her work, she concluded that there is a direct relationship between the quality of school facilities provided and the quality of the products of the school. Asiabaka (2010) in her work on the need for effective facility management in schools in Nigeria observed that the most fundamental problem in facility management is lack of policy guidelines for infrastructural development in schools. She added that in some schools, there are inadequate classrooms, staff offices, laboratories, workshops, libraries and study areas while in some schools, these facilities are adequately provided. She further said that this situation arises because authorities have failed to establish policy directives on minimum standard in relation to school facilities.

According to Oyelere (1983) the problems associated with Science and Science teaching is poor management of laboratory equipment and materials, supply of substandard equipment etc. Hassan (2008) opined that mismanagement of funds and available apparatus or equipment is also a problem to Biology teaching. She further said that where funds are available, they are often mismanaged, in the sense that fake and non-durable equipment are often bought. The available equipment is not usually managed well and taken care of adequately thereby reducing the durability of the equipment and the desired results. In this era of unskilled or lack of laboratory assistants to run the laboratories, the biology teachers face the problem of doing virtually everything, ranging from preparation of reagents and solutions to detecting and effecting minor repairs of faulty equipment and organising the students and materials/materials for practical work (Nwagbo,2008).Most activities that go on in the lab, like the experiments are dangerous in their own way and students should be taught the dangers inherent in such activities and how to avoid the hazards. The safety measures to be taken in the lab are in two categories:

a. Measures taken to prevent accident
b. Measures taken to care for injuries and damage caused by the accident.

Accidents in the lab could result from fire, cut from glass wares, heating substances and dangerous chemicals. These are measures taken to ensure safety for all users of the lab facilities and lab properties. i.e., when working in the lab the following habits should be followed:

1. Always wear protective glass, clothing at all times
2. Always read the label on reagent bottle twice and carefully
3. Always check glass-ware for cracks before use.
4. Glass storage bottle should be placed at or near floor level.
5. Point away from person test-tubes or any piece of equipment which may expel a gas or liquid
6. When diluting acids, acids should be slowly added to water and not vice-versa.
7. Report all injuries however minor, breakage and faulty equipment
8. Always flush drains whenever chemicals are poured in
9. Always label container correctly with the full name and concentration of the content.
10. Know the position of the first aid box, fire extinguisher and other safety equipment and how to operate them.
11. Corrosive chemicals should only be brought in to the teaching laboratories when needed. They should never be stored above the shoulder height of the shortest person using the laboratory.
12. Eating, drinking and smoking in the laboratory are hazardous. Do not drink from laboratory taps.
13. Always wash your hand before leaving the laboratory and leave your lab coat behind.
14. All organic chemicals other than food stuffs should be treated as toxic. etc.

2.11 Theoretical Framework

Theoretically, this study is based on constructivism and experiential learning. The notion of using observations and experiences in education to provide pupils with concrete experiences of things and concepts dates back to the seventeenth century (Morris, 2020). According to the National Education Association in 1893, "the study of books is well enough and undoubtedly important, but the study of things and of phenomena by direct contact must not be neglected." Prior to the 1950s, laboratory learning focused mostly on idea validation, information transmission, and procedural routines, rather than widening students' competence and knowledge enquiry (Morris, 2020). John Dewey (1859–1952), an American education reformer, promoted active learning in his progressive education movement's "learn by doing" method.

Experiential learning is a constructivist learning theory defined as ‘learning by doing’. The learner is an active participant in the educational process, and learning is achieved through a continuous cycle of inquiry, reflection, analysis and synthesis (Bartle, 2015) Eexperiential learning is the process whereby knowledge is created through the transformation of experience. Knowledge results from the combinations of grasping and transforming the experience. (Kolb, 1984). Kolb again indicated that by participating in experiential learning, students are engaged in authentic learning experiences that position them as active participants in their learning. They develop the ability to bridge the gap between theory and practice and integrate learning beyond the classroom. Experiential learning can increase student engagement, improve learning effectiveness and enhance work and life skills. The teacher’s primary role in experiential learning is to create suitable learning experiences and facilitate the learning process, rather than direct instruction.

Kolb's experiential learning cycle is comprised of four major modes of learning:

- Concrete experience: the learner has a hands-on experience connected to the learning outcome.
- Reflective observation: the learner reflects and reviews the experience from a range of different perspectives.
- Abstract conceptualisation: the learner analyses and connects the experience to previous learning and develops new ideas about the content being taught.
- Active experimentation: the learner acts on their new ideas by experimenting in an experiential setting.

All four learning modes must be addressed for learning to be most effective. As new ideas are put into action, a new cycle of experiential learning begins. Experiential learning can be used to support students to undertake learning in a variety of campus-based, project-based, work-integrated and community contexts. It is beneficial to identify experiences that students will have an interest in. These experiences should be structured to require the learner to take the initiative, make decisions and be accountable for results, including learning from natural consequences, mistakes and successes. Examples of experiential learning activities include:

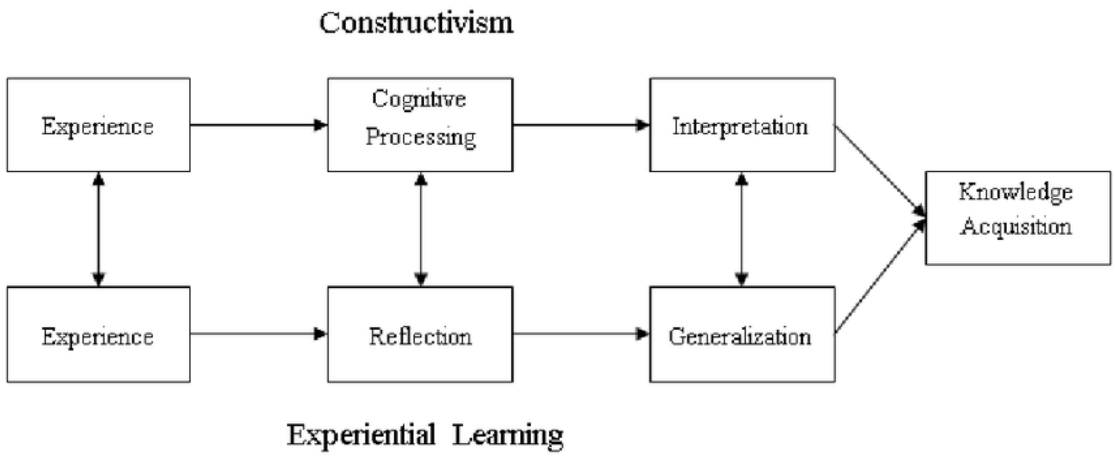
- applied research projects
- case studies
- field experience
- simulations
- laboratory work
- work integrated learning.

Students are supported in reviewing and reflecting on their experience, often through a set structure or activity to focus on reflection. This activity could include written reflections, reflecting with others or creative reflections. Critical reflection and reflective practice are not innate skills. Students will often need to be actively taught these. Reflections serve as valuable formative assessments and help students construct meaning and draw connections between new information and their existing knowledge, experiences and ideas. (Kolb 1984)

Students' major goal in laboratory learning used to be to build practical competence in their area of expertise in order to make sense of the theoretical concepts given in class (Abrahams & Millar, 2008). By the twentieth century, however, laboratory learning had evolved to other educational goals such as communication skills, teamwork, problem solving, and creative thinking, rather than just practical ability (Abrahams & Millar, 2008). These learning outcomes are an essential aspect of the scientific research cycle because they offer the empirical foundation for the development and improvement of theories as well as indicators for making predictions (Abrahams & Millar, 2008). It encourages students to depend on evidence from their own practical experiments rather of relying exclusively on information from lecturers and textbooks. It guarantees that students acquire not just the body of scientific information, but also the methods through which it came to be. Several scholars, such as Shulman and Tamir (1973), created diverse laboratory pedagogy aims. These goals included establishing students' higher levels of cognitive skills such as problem solving, creative thinking, inquiry skills, and appreciation of scientific theories and models, as well as transforming laboratory learning into the core of the science learning process rather than just a confirmation step (National Research Council, 2012). As a result, constructivism strives to prepare students to solve issues in ambiguous settings. Learners, according to constructivists, create their own world or at least interpret it based on their perceptions of experiences, thus an individual's knowledge is a product of his or her prior experiences, mental structures, and beliefs that are used to understand things and events. What a person understands is dependent on his or her view of physical and social events that the mind comprehends (Anderson, 2018).

The constructivist approach to teaching and learning has prompted demands for a significant shift in classroom environments away from the traditional transmission model of instruction and toward one that is far more complex and participatory (Gold, 2001). Problem-oriented activities, visual formats and mental models, collaborative learning, learning via inquiry, and genuine assessment are all common features of this shift in the classroom setting. However, data reveals that there hasn't been much of a shift in that direction, and teacher-centered activities continue to be the norm in scientific classes (Lewis & Reinders, 2007). Every competent teacher with a constructivist approach to teaching is responsible for creating a learnable atmosphere according to Brooks and Brooks (1999), as reported by Savasci and Berlin (2012). The figure below shows the comparison of constructivism and experiential learning.

Figure 1: Comparison between experiential and constructivism learning.



2.12 Conceptual Framework

In the field of education, instructional resources are critical. They help in teaching and learning by containing everything that delivers information to both the teacher and the student. Instructional resources, according to Kessler (2018), are all types of material used to promote, support, and enhance teaching and learning activities in the context of education. According to Ajelabi (2000), instructional materials are teaching-learning resources that are used in the distribution of educational information to students in the classroom. He goes on to say that it makes the lesson more real, realistic, and successful by motivating students to study at their own speed, rate, and convenience. Our perceptions and understandings of our surroundings, he claims, differ as follows:

- 75% of all information perceived is absorbed by the eye
- 15% is absorbed by the ear
- 10% is equally distributed among the remaining senses- touch, smell and taste.

Mutebi and Matora (2000) also stressed the importance of using instructional materials in teaching and learning. They claim that we recall 10% of what we hear, 40% of what we talk about with others, and up to 80% of what we personally experience or do. This meant that using instructional materials might help pupils learn more successfully. Teaching and learning encounters make use of instructional resources to broaden the area of understanding (Onyejemezi, 2002). Finally, Onyejemezi enumerated the following seven advantages of instructional materials:

- It supplies concrete basis for conceptual thinking and reduce meaningless response of student.
- It makes lesson more permanent. It has a high degree of interest since they are shown physically to aid self-understanding and explanation.

- It offers reality to experience.
- It contributes to the depth and variety of learning.
- It gives readymade answers to questions in the teaching-learning process.
- It adds meaning and explicitness in the teaching-learning process.

Bizimana and Orodho (2014) claim that the usage of instructional materials prevents rote learning. Furthermore, according to Oremeji (2002), instructional information products are extremely useful for conveying information, clarifying difficult and abstract concepts, sparking thoughts, sharpening observation, developing curiosity, and fulfilling individual variances. Overall, the importance of using instructional materials in the classroom cannot be overstated, since it is an essential component of classroom education.

According to Roth McDuffie and Mather (2006), instructional materials are any materials or resources utilized in a teaching activity to help students have a better knowledge of the learning process. They are employed, according to her, to produce the richest possible learning environment, which aids the instructor and students in achieving specified goals. They also help teachers communicate more effectively, and students learn more effectively and long-term. Pimthong and Williams (2018) agree, describing teaching resources as "everything that assists the instructor in promoting teaching and learning activities." Sifakis (2007), who shares the aforementioned viewpoint, describes teaching aids as items that are designed to assist the instructor teach more effectively or, better yet, to make it easier for the students to learn. Many educational technologists regard instructional materials as instruments and resources utilized in learning contexts to augment written or spoken words in the transfer of information, attitudes, ideas, concepts, and values, according to Ottenbreit-Leftwich *et al*. (2010).

According to Akinlaye (2003), instructional materials are "items or objects that are brought into play to accentuate, clarify, reinforce, and vitalize the teacher's lesson." Ajelabi (2000) defines instructional materials as teaching-learning resources that are used in imparting educational information to the student and are an intrinsic part of the classroom instructional process. It also makes the instruction more genuine, tangible, and effective, according to him. Learners are inspired to study at their own speed, at their own rate, and at their own convenience. Resources are defined by Maduabum (2001) as "equipment and materials that the teacher can employ to assist in the attainment of instructional goals."

Dogara and Ahmadu (2000) defined resources as "everything that aids in achieving classroom success." Resources may also be described as all of the sources of assistance available to an individual or a student in order to achieve learning objectives. Resources, according to Arruabarrena (2019), are all people and things capable of transmitting knowledge, values, processes, experiences, and strategies that may be utilized to actively involve students in the learning process.

There are various resources that can be used for science teaching. Some of these are;

- Physical resources such as school building, classrooms, school plants, laboratories, libraries, etc.
- Human resources such as teachers, students and supporting staff
- Material resources such as laboratory equipment and chemicals, teaching aids, bulletin board, etc.

- Time resources such as number of periods per week, duration of lesson, school calendar, etc.
- Environmental resources such as items in the locality, household appliances, teaching or storage spaces, industrial resources, etc.
- External resource persons such as carpenters, mechanics, etc.
- Technological resources such as computers, radio/television, projectors, etc.
- Instructional materials such as textbooks, teacher's guides, exercise books, etc.

We are all aware of the shortcomings in the supply, utilization, availability, and administration of these resources in schools today. However, for successful learning, it is critical to make the most use of these resources while teaching and learning science topics. A global shift in science education resulting from the knowledge explosion and its new wave of scientific and technological growth need high-quality science instruction (Collins, & Halverson, 2018). The shift necessitates the supply and usage of resources that promote successful scientific teaching and learning.

Abubakar (2014 Abubakar) divided resources into two categories: human and material resources. The learner or student, the laboratory technician, and the instructor are all examples of human resources who contribute directly or indirectly to the attainment of science, technology, and mathematics objectives. Material resources include instructional facilities such as classrooms, labs, equipment and supplies, and textual materials that are utilised to ensure successful teaching and learning. The use of existing instructional materials to assist successful scientific teaching and learning by secondary school teachers, according to the author, is a positive trend. This is in line with Okebukola (2002), who claims that science teachers should go beyond the conventional scientific teaching method and make use of the existing people and natural resources in the environment to help students understand science.

The instructional materials have certain intrinsic benefits that set them apart from other teaching resources. For starters, they give teachers with engaging and compelling platforms for imparting knowledge by motivating students to study more. The learner's interest and curiosity are further piqued by giving opportunities for solo study and references. Furthermore, the instructor is supported in overcoming physical challenges that may have hampered his ability to effectively convey a specific topic. They make teaching and learning more enjoyable and less stressful in general. They are equally important accelerators for the learners' social and intellectual growth.

According to Bolick *et al.* (2003), there is a strong link between successful teaching and the utilization of instructional resources. "While some educators have been enthralled by the potential of instructional materials to enhance teaching and learning," Bolick *et al* asserted, "teachers have lagged behind in employing instructional materials during teaching and learning." Others questioned if instructional resources, for example, will ever inspire classroom transformation in biology. As a result, instructional materials are essential components of a teaching-learning setting; they are meant to enhance rather than replace learning. It consequently follows that, in order to have an effective teaching and learning activity, instructional materials must be used.

"Teaching equipment and materials have evolved over time, not just to facilitate teaching and learning circumstances, but also to satisfy the instructional demands of individuals and groups," Chukwu, Eze and Agada (2016) write. Printed, audio, and visual instructional materials are made up of things that help in the successful delivery of a lesson. To this purpose, instructional materials are defined as objects or items that a teacher can utilise in the classroom to help him relax while teaching. However, while instructional materials cannot solve all of the difficulties associated with teaching and learning, they may go a long way toward helping to solve them, simply because they are extra equipment that can impact the reality of teaching and learning activities.

Science teachers who have not had enough hands-on experience with activities and experiments won't be able to teach effectively. For example, Sadeh & Zion (2009). believe that exposing students to laboratory activities and experiments is the cornerstone of scientific education and, in reality, the future of science education, both in terms of skill development and comprehension of the fundamental concepts and applications of science. A curriculum that lacks human and material resources would, without a doubt, fail to generate the required results. To put it another way, significant human and material resources are required for the program to yield meaningful outcomes. However, the current status of senior high school infrastructure in the Central Region and Ghana as a whole leaf a lot to be desired. There are insufficient labs, workshops, and classrooms to offer even the most basic secondary school core curriculum. Several scientific educators and academics have demonstrated that there is an undeniable reality that resources for science teaching and learning are in low supply in Ghanaian classrooms (Abukari *et al.,* 2015).

CHAPTER THREE

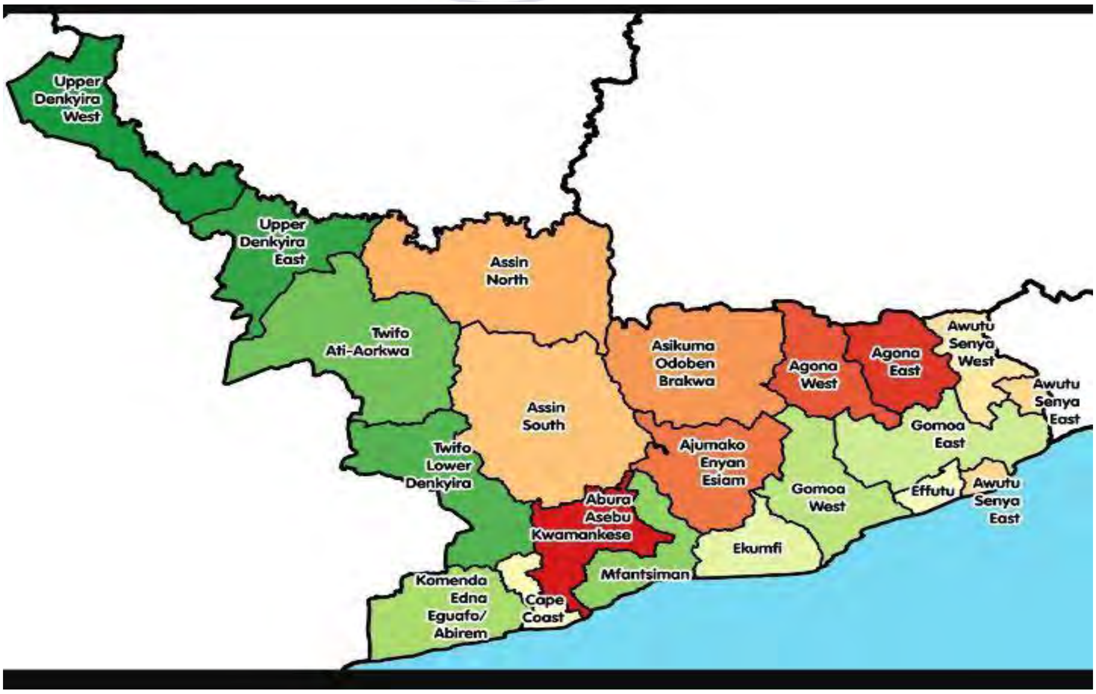
METHODOLOGY

3.0 Overview

This chapter presents the methodology that was employed in the study. It includes the research design, area of the study, population, sample size and sampling technique, the instruments used, validity and reliability of instruments, data collection procedure and data analysis.

3.1 Study Area

This study was carried out in public senior high schools in the Central Region of Ghana. Located in the South-Western centre of Ghana, the Central Region shares boundary with the Ashanti Region in the North, Eastern Region to the North-East, Greater Accra Region to the South-East and on the West by the Western Region. It is bounded to the South by the Gulf of Guinea. With Latitude: 5º 29’ 59.99” N and Longitude: -1º 00’ 0.00” W.



3.2 Research Design

Research design is a scheme, outline, or plan that is used to generate answers to research problems (Kombo & Delno, 2006). It is a detailed documentation of plan for the collection, measurement, and analysis of data. It constitutes the blue print for the collection, measurement, and analysis of data (Saunders, Lewis & Thornhill, 2007). A descriptive survey research design was employed in this study. Descriptive research is a study to determine the nature of a situation as it exists at the time of the study (Clandinin & Connely 2000). According to Kerlinger and Lee (2000), a descriptive survey research attempts to determine the incident, distribution and interpretation among sociological and psychological variables. Simon and Usher (2000) also observed that the descriptive survey method enables the researcher to obtain opinion from the representative sample of the target population so as to be able to infer the perception of the entire population. Therefore, a descriptive survey method was considered appropriate for this study to determine the Level of availability and utilisation of Biology Laboratory Facilities by teachers in selected senior high schools in the Central region of Ghana.

3.3 Population of the Study

The target population defines those units for which the findings of the study are meant to generalise (Lavrakas et al, 2019). The target population of the study was all the biology teachers in the 40 Category C Senior High Schools in the Central Region of Ghana.

3.4 Accessible Population

The accessible population defines the portion of the population to which the researcher has reasonable access (Lavrakas et al, 2019). Therefore, the accessible population of the study was 120 teachers from the 40 category C Senior High Schools in the central region. Three teachers were selected from each school.

3.5 Sample and Sampling Technique

According to Pandey and Pandey (2015), sampling means selecting a given number of subjects from a defined population as representative of that population. It works with the objective to obtain accurate and reliable information about the population with minimum of cost, time and energy and to set out the limits of accuracy of such estimates. It makes exhaustive and intensive study possible with much less time, money and material, (Pandey & Pandey, 2015). All 40 Category C schools were used for the study. Three biology teachers from each school, giving a total of one hundred and twenty (120) respondents were sampled using purposive sampling techniques.

3.6 Research Instruments

The following instruments were used for this study. They are the Biology Laboratory Facilities Checklist (BLFCL) and Questionnaire. The biology laboratory facilities checklist for teachers consisted of sixty items (60) which focused on the availability of the equipment. It was adopted from Okafor (2014) and modified to suit the objectives of this study. The respondents were to show whether the equipment is available and functional or not available or available but not functional. The checklist was to determine the Level of availability of Biology Laboratory Facilities in the senior high schools in Central Region. Three teachers from each school were sampled to respond to the checklist. Alongside, the researcher responded to one checklist in each school by observing the various facilities available and with the assistance of the teachers, making a total of six (4) checklists answered in each school. The respondents were to show whether the equipment is available or not available. To enhance efficient analysis, the data obtained were categorised by schools. The number of facilities for each school that were checked "available" as against the number who checked "not available" were collated using frequency counts and then converted into simple percentages.

Questionnaire: This instrument was used for survey research of 40 senior high schools across the region. The questionnaire has two parts; part A is personal data, part B has 20 items to answer Yes or No, on laboratory utilisation. The respondents were three biology teachers from each school making a total of 120 teachers. The questionnaire observed the level of exposure to biology laboratory exercises among Category C Senior High Schools in Central Region, thus observing those that do not have as well as how these laboratories are utilised. This was analysed using frequency count arising from the information gathered.

3.7 Validity and Reliability of the Instruments

Prior to using the instruments, their validity and reliability were assessed to determine their accuracy and consistency. According to Cresswell (2015), the goal of a good research is to have measures that are reliable and valid. Validity is concerned with whether the findings are really about what they appear to be about (Winter, 2000). According to Treagust, Won and Duit (2014), validity is based on the view that a particular instrument measures what it purports. The instruments were face and content validated. The checklist was validated by two experts (lecturers). The terms of reference for the validation are to assess whether (a) the items were in line with what they were supposed to measure. (b) The language of expression was simple and clear. The instrument was found capable of measuring the variables. The Chronbach alpha reliability coefficient was used to determine the reliability of the questionnaire. It was administered to biology teachers of Private Senior High school in Winneba. The results were analysed for the reliability coefficient. A reliability co-efficient of 0.80 is considered appropriate (De Villiers, 1991).

3.8 Data Collection Procedure

The researcher visited the sampled schools with an introductory letter seeking the permission of the school administrators to carry out the collection of data on the research work. The administration and the collection of the questionnaire were carried out by the researcher with the assistance of some assigned biology teachers by the heads of science departments. The laboratory facilities checklist used to check the level of availability of Biology Laboratory Facilities that the school has was distributed to the biology teachers as well as the questionnaires. As much as possible, all questionnaires administered to biology teachers were collected by the third day. Non responses were followed up thrice and eventually all completed questionnaires were retrieved. This procedure resulted in a return rate of 100%. After sorting out the scores, the data were analysed based on the objectives of the study.

3.9 Method of Data Analysis

Coding schemes were developed to organize the data into meaningful and manageable categories. This involved the data obtained from the Biology Laboratory Facilities Checklist (BLFCL) and the Questionnaire. The categorized data were later converted into frequency counts and simple percentages, and used to answer the research questions addressed in the study. This study, in keeping with current or recent trends in the learning environment with regards to the classroom and laboratory, employed quantitative methods in analysing the data collected (Brannen, 2017). This was done using Statistical Package for Social Science (SPSS) version 16 and Microsoft excel spreadsheet. The practice whereby a quantitative measure is included in a research study is generally accepted as enhancing the study (Fraser, 1998). The table below shows the analysis framework for the study.

Table 1: Framework of Data Analysis

Research Questions	Nature	Unit of Analysis	Statistical Tool (s)
1	Quantitative	BLFCL	Frequency counts, Simple percentages
2	Quantitative	Questionnaire	Frequency counts, Simple percentages
3	Quantitative	Questionnaire	Frequency counts Simple percentages
4	Quantitative	Questionnaire	Frequency counts, Simple percentages

3.10 Ethical Consideration

In order to gain access to both teachers in the selected schools, permission was obtained from various school heads. In this regard, a letter was written explaining the purpose of the study and why the data was needed from the teachers. Permission was subsequently granted for data to be collected. Before the questionnaires were administered, the researcher further explained the purpose of the study to the respondents, and assured them of anonymity and confidentiality of information that was given. This gave respondents the confidence to freely and honestly respond to the instruments.

CHAPTER FOUR

DATA PRESENTATION AND DISCUSSIONS

4.0 Overview

This chapter presents the analysis of data obtained from the Biology Laboratory Facilities Checklist (BLFCL) and the Questionnaires on laboratory utilisation and factors that hinder the effective use of laboratories. It involves frequency counts and simple percentages of various data categories. The research questions addressed in the study are thoroughly discussed under this chapter.

4.1 Answer to Research Questions

RQ1: What are the available biology laboratory facilities for use by teachers?

4.1.1: Analysis of the level of availability of biology laboratory facilities

Table 2: Available Laboratory Facilities and Their Descriptions

Percentage (%) Range of Available Facilities	Description
Above 40	Very adequate
30 to 39	Adequate
20 to 29	Fairly adequate
Below 20	Inadequate

Source: Researcher's Field Work, 2021

Table 3 below shows the analysis of the data from the BLFCL used to investigate the level of availability of Biology laboratory Facilities in Category C Senior High Schools in Central Region.

Table 3: Level of availability of laboratory facilities

Number of facilities available	Number of schools	Percentage number of schools	Description
Above 40	0	100	Very adequate
30 to 39	12	30	Adequate
20 to 29	15	37.5	Fairly adequate
Below 20	13	32.5	Inadequate

Source: Researcher's Field Work, 2021

From Table 3, the results show that none of the forty sampled schools had very adequate biology laboratory facilities in their laboratory. Twelve (12) of the schools had adequate laboratory facilities, having percentage score of 30%. Fifteen schools were fairly adequate indicating 37.5%, yet these were not enough to efficiently run biology practical work without difficulties. Apparently, most of the conventional equipment needed in a modern senior high school biology laboratory was lacking. Thirteen schools sampled were designated inadequate. They had a score of 32.5% They only have basic biology equipment, materials and glassware which were not adequate to perform a biology practical work without having to improvise.

Teachers obviously have to either improvise in order to demonstrate a scientific concept or neglect the importance of practical work altogether. Ahmed (2003) revealed that in most of the nation's secondary schools, teaching and learning take place in a non-conducive environment, lacking the basic materials and thus hindered the fulfilment of educational objectives. These schools scored below 20% on the Biology Laboratory Facilities Checklist (BLFCL).

This finding of this research is similar to a study conducted by Nnorom (2012), "Availability and Usability of Science Laboratory for Teaching in Upper Basic

Secondary Schools". The study's findings revealed that in most participating schools had no separate science laboratories.

4.2: RQ 2: To what extent are laboratory resources being used by teachers in teaching practical lessons in biology?

4.2.1 Analysis of Teachers Usage of Laboratory Resources in Teaching Practical Lesson

Table 4 below shows the analysis of the responses derived from the teachers on the utilisation and impact of biology laboratory facilities on students' academic performance.

Table 4: Frequency count table on laboratory Utilisation and the impact on students' academic performance

S/N	Question	Responses					
		Yes		No		Total	
		Freq.	%	Freq.	%	Freq.	%
1	Does the school have biology laboratory?	97	80.8	23	19.2	120	100
2	Do you use biology laboratory equipment for practical work?	19	15.8	101	84.2	120	100
3	Has practical been conducted this term?	50	41.7	70	58.3	120	100
4	Are there available equipment in your laboratory?	20	16.7	100	83.3	120	100
5	Is the laboratory conducive or safe enough to carry out biology practical?	52	43.4	68	56.6	120	100
6	Are the equipment replaced immediately when broken or missing?	0	0	120	100	120	100

7	Do you improvise materials that are not available in the biology laboratory for practical activities?	36	30.0	84	70.0	120	100
8	Does the practical work facilitate effective teaching and learning?	36	30.0	84	70.0	120	100
9	Does practical work influence students' academic performance positively?	50	41.7	70	58.3	120	100

Source: Researcher's Field Work, 2021

The summary of the entire exercise indicates that, there is poor utilisation of laboratory facilities in category C senior high schools across the region. From item number one in Table 3, 19.2% representing 23 participants indicated that they do not even have biology laboratory at all. They just had few materials that are mostly not functional and are placed in cupboards in the corner of the classroom. Abdulrahman (2009), contended that the availability of physical and material resources is very significant for the success of any worthwhile educational endeavour. These researchers agreed that, availability of adequate school buildings, number of classrooms, chairs, desks and laboratories for science teaching are imperative for the attainment of any educational objectives. In his study, Abdulrahman (2009), found a significant relationship between teachers, facilities and schools' academic performance.

From item number two, one hundred and one (101) participants representing 84.2% indicated that they do not use biology laboratory equipment for practical work. Hence majority of the schools do not use laboratory equipment

Item number three indicates that 58.3% representing 70 teachers indicated that practical have not been conducted within the term in biology. The reason being that, there are not enough available laboratory materials so teachers have to improvise, which teachers feel reluctant to do so due to the workload. Item number four shows that 83.3% representing 100 teachers indicated that the available equipment in the biology laboratory is not enough. Also, item number five shows that 56.6% indicated that the laboratory is not conducive enough to offer biology practical. This is due to the dilapidated nature of the laboratory and the lack of accessible facilities and equipment.

In item number six, there were hundred percent (100%) indications that equipments are not replaced when broken in the laboratory. This will affect students' performance if allowed to work in such laboratories. Oboh (2008), opined that teaching biology in most of the Ghanaian schools is more of theoretical than practical and the usual reason is the unavailability of materials and equipment.

In item number seven, to ascertain whether teachers improvise materials and equipment when the conventional materials are not available had 70% of the respondents responded negative which is an obvious indication that the students in such schools are going to perform poorly academically. Improvisation is vital in science teaching and learning, especially when materials and equipment in the laboratory are not adequate to meet the class size (Rothsak, 2013)

In item number eight, only thirty percent (30%) of teachers indicated that practical work in class facilitates effective teaching and learning. The remaining seventy percent (70%) representing 84 teachers indicated the opposite. This is obviously due to the lack of apparatus which could have serious implication on the quality of school output (Adeyemi, 2006).

In item number nine, only 41.7% indicated that practical work influences students' academic performance positively, which confirms to what Ubaja (2008) said, that there is sharp fall in students' academic performance due to quality of some laboratories and inadequate materials. So as to effectively teach Biology both in the classroom and the laboratory, a multiple teaching aids or equipment need to be created, arranged and implemented. This arrangement is very important in terms of teacher-student interaction and communication. The essential elements for creating a multi-faceted environment are equipment. Equipment used in biology teaching cannot be limited in a classroom, it also covers a wide area that addresses the nature in a broader sense. All opportunities provided by science and technology should be utilised in order to improve the quality of education, to ensure that students gain effective and permanent knowledge, and to share today's rapidly changing and developing knowledge with students (Yesler, 2007).

Survey research conducted by the researcher round the forty (40) senior high schools across the central region revealed that, there is a poor conduct of laboratory exercises. This implies that most schools in the region do not conduct biology laboratory exercises with their students, or they conduct very few laboratory exercises below expectation.

According to Carnduff and Reid (2003), the use of equipment in Biology education is very effective in students' gaining cognitive, affective and psychomotor behaviours. Particularly during laboratory works, affective and psychomotor gains come to the fore. It has been stated that the atmosphere of the laboratory, the smell of acids and bases in the environment, the presence of some experimental tools, or animal and plant samples in some laboratories can motivate students and stimulate their creativity and discovery skills.

4.3: RQ 3: What is the level of exposure of senior high school students to biology laboratory exercises in Central Region?

4.3.1 Analysis of the Level of Exposure to Biology Laboratory Exercises

Table 5: Frequency count table on Level of Exposure to Biology Laboratory Exercises

S/N	Questions	Responses					
		Yes		No		Total	
		Freq.	%	Freq.	%	Freq.	%
4.	Does each of your students handle laboratory equipment independently during practical work?	0	0	120	100	120	100
5.	Do your students conduct practical work in groups?	50	41.7	70	58.3	120	100
	Does the practical work facilitate effective teaching and learning in class?	36	30.0	84	70.0	120	100
7.	Do students engage themselves effectively in practical work	36	30.0	84	70.0	120	100

Source: Researcher's Field Work, 2021

The summary of the entire exercise indicates that, there is poor conduct of laboratory exercises in category C senior high schools across the region. Item number one in Table 5 shows that, all the respondents thus 120 teachers representing 100% indicated that their students do not handle equipment independently during practical work.

From item number two seventy respondents (70) representing 58.3% indicated that they do not conduct practical in groups. According to Lord (2001), it has been observed that when biology practical is done in groups, it becomes a very pervasive and influential feature of the classroom ecosystem, which must be encouraged in the teaching and learning of biology in schools.

Also from item number three, eighty-four (84) respondents representing 70% indicated that their students do not cooperate during practical lesson and as such, does not facilitate effective teaching and learning. This is probably due to the fact that there is not enough equipment for the laboratory exercises and as such the lesson becomes boring for students to cooperate well. A research study conducted by Fraser (2002) showed that learning environments do not only have the positive correlation with the student's outcomes, motivations, and attitudes, but also teachers' motivation. Frasers study on learning environments were focused on student's outcomes, students' and teachers' perceptions, and evaluation of the strategies. According to him, the factor that contributes most to self-evaluation is the learning environment. Such an environment allows students to synthesize, analyse, explore, criticize and create their own concepts about the learning material.

From item number four, thirty percent (30%) showed that students engage themselves effectively in practical work, the remaining 70% representing 84 respondents do not. According to Oyetunde (2008), the resultant effect is overcrowding of pupils in the schools leading to overstressing of available spaces and facilities, which is affecting most secondary schools in Ghana.

Ihejirika, (2019) identified the following factors for the poor performance of students in Biology as:

- Almost every student with or without ability is enrolled for the subject.
- Poor quality of science teachers.
- Overcrowded classroom.
- Lack of suitable and adequate Science equipment.
- Over-loaded syllabus.

- Poor and careless diagrams.
- Poor labelling and poor use of biological terminology.

This is a clear indication that there is a poor conduct of laboratory exercises in biology across Category C Senior High Schools in Central Region.

This result is in agreement with the findings of Abdulrahman (2009) as cited by Okafor (2014) that, as a results of the persistence of sparsely furnished laboratories in senior high schools that cannot support effective laboratory biology lessons, discussion and lecture methods of teaching have been dominating the teaching and learning activities where students need to do practical work.

4.4: RQ 4: What are the factors that affect the effective use of laboratory resources in teaching Biology to senior high school students in Central Region?

4.4.1 Analysis of Factors That Affect the Effective Use of Laboratory Exercises

A questionnaire was used to gather responses from participants on the factors that hinder the use of laboratory exercises. The questionnaire demanded teachers to tick yes or no concerning the factors that hinder the effective use of laboratory exercises to teaching biology in their schools. The responses are shown under Table 7

Table 6: Factors That Affect the Effective Use of Laboratory Exercises

S/N	Listed Factors	Responses (Yes/No)

		Freq. Count of Questionnaire	**Total**	**%**
1.	Lack of teachers' motivation (incentives)	120	120	100%
2.	Lack of adequate laboratory equipment and materials	116	120	96.7%
3.	Teachers' work load	89	120	74.2%
4.	Lack of laboratory attendant	58	120	48.3%
5.	It is time consuming	27	120	22.5%
6.	Large class size	27	120	
7.	Workshops are not organised for teachers to enhance further studies	58	120	22.5% 48.3%

Source: Researcher's Field Work, 2021

The three factors with high percentages given were:

i. Teachers work load (74.2%)

ii. Lack of adequate laboratory equipment and materials (96.7%) and

iii. Lack of teacher's motivation (incentives) (100%)

In summary, teachers' responses to the questionnaire indicate that there is 100% support that incentives should be given to teachers, as a means of motivating them to perform science practical. One of the major problems that biology teachers experience is that they feel that carrying out too much activities in the laboratory amount to inviting trouble since the practical work is tedious. Moreover, the topics are so restricted to examination scheduled curriculum that teachers must comply to if they want their students to pass their external examination. This in turn increases the workload of the teachers. (Ihejirika, 2019). So, these under-motivated teachers feel reluctant to teach their students effectively.

Ninety-six percent (96.7%) respondents representing 116 teachers indicated that their schools lack laboratory equipment, and this is another major factor that affects the effective use of laboratory exercises. Bonah (2015) said that lack of equipment/materials have provided excuses for Biology teachers who now neglect the practical aspect which has greater potential for developing critical thinking and objective reasoning ability in students. They resort instead to expository method of teaching which is known for promoting rote learning and hindering transfer of learning.

Seventy-four-point two percent (74.2%) representing 89 respondents or teachers indicated that teacher's workload affects the effective use of laboratory exercises. Ihejirika (2019) attributed poor academic performance of students in Biology to poor state in which science is being taught in schools. "Chalk and talk" method has been the most widely used science teaching due to poor quality laboratory, large class size and much work load on the teachers.

Forty-eight-point three percent (48.3%) representing 58 teachers stated that they lack laboratory assistants to help them manage the laboratory and that affect the effective use of the laboratory due to the workload on the teachers. The available equipment is not usually managed well and taken care of adequately thereby reducing the durability of the equipment and the desired results. In this era of unskilled or lack of laboratory assistants to run the laboratories, the biology teachers face the problem of doing virtually everything, ranging from preparation of reagents and solutions to detecting and effecting minor repairs of faulty equipment and organizing the students and materials/materials for practical work (Nwagbo,2008).

Again, forty-eight-point three percent (48.3%) representing 58 teachers indicated that workshops are not organised for teachers in their schools to boost their already existing knowledge in the teaching of biology. Ahmed (2003) revealed that in most of the nation's Secondary Schools, teaching and learning take place under a most non conducive environment, lacking the basic materials and thus hindered the fulfilment of educational objectives. Lack of adequate facilities such as text books, workshops, ill equipped classrooms, laboratories and libraries are among the probable causes of student's poor performance in examination.

CHAPTER FIVE

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.0 Overview

This chapter presents a summary of this research work, the conclusion, recommendations proposed by the researcher and suggestions for further studies.

5.1 Summary of the Study

The teaching and learning of biology require the utilisation of facilities and equipment in order to develop in students, scientific skills and academic performance in Biology. The non-availability of laboratory facilities and inability to utilise the existing ones has affected the academic performance of students in institutions of learning particularly in senior high schools (Abdulrahman, 2009). This study therefore sought to investigate the availability and utilisation of biology laboratory facilities by teachers in Category C Senior High Schools in the Central Region of Ghana. In the course of this study, four research questions were developed to guide the study. This study has some significance such as providing information on the importance of laboratory facilities, encouraging regular supervision on senior high schools etc. The study was delimited to only schools recognised as category C because it is these schools that are often at disadvantage in terms of availability of laboratory facilities and equipment.

Chapter two reviewed the work of other researchers related to this study. Descriptive survey design was adopted for the study. Forty schools with three biology teachers from each school, giving a total of one hundred and twenty (120) respondents were sampled using purposive sampling techniques**.**

The instruments used were 'Biology Laboratory Facilities Checklist for teachers (BLFCL) and a questionnaire. The BLFCL consisted of sixty items (60) with two options which focused on the availability of the equipment. The respondents were to show whether the equipment was available or not available. The questionnaire consisted of twenty items with Yes or No answers on laboratory utilisation. Prior to using the instruments, the validity and reliability were assessed to determine their accuracy and consistency. The administration and the collection of the instruments were carried out by the researcher with the assistance of some assigned biology teachers. Coding schemes were developed to organise the data into meaningful and manageable categories. The categorised data were later converted into frequency counts and simple percentages, and used to answer the research questions addressed in the study.

The result of the study showed that Category C Senior High Schools in the region are ill-equipped and this resulted in poor conduct of laboratory exercises in these senior high schools across the region. Other reasons given by teachers for poor conduct of laboratory exercises included teachers work load, lack of adequate laboratory equipment and materials and lack of teacher's motivation (incentives). Details of the findings and discussion are reported in chapter four.

5.2 Conclusions

From the findings, the following conclusions are drawn from the study:

- There are no adequate biology laboratory facilities in all the senior high schools surveyed.
- There is poor conduct of laboratory exercises in category C senior high schools across the region, which could be one out of many reasons for students' poor performance in external examination such as WASSCE.

- The major hindrances to the effective use of laboratory exercises in teaching biology in category C senior high schools in central region include lack of teachers' motivation.
- Too much workload and lack of laboratory equipment and materials.
- Workshops are not organised for teachers to enhance their knowledge in biology

5.3 Recommendations

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

- Government should make sure that all the senior high schools, especially the category C schools have well equipped science laboratories. They should provide these schools with adequate equipment and materials for science practical work.
- Biology teachers should see laboratory exercises as a need that cannot be avoided.
- The government should motivate science teachers with science allowance.
- Educational planners/administrators should always put into consideration provision for laboratory exercises for students to acquire scientific skills.
- There is the need for the science (particularly biology) inspectorate division of the Ministry of Education and the heads of departments of biology to conduct regular inspections to the public schools to see that the facilities are used for the purposes they are meant for.
- Science teachers should be sent on further studies, seminars and workshops to update their knowledge on the use of the biology laboratory facilities.
- A manual of biology laboratory facilities should be provided to biology teachers to enable them know how to handle the facilities.

5.4 Suggestions for Further Study

Based on the research carried out, the following suggestions were offered for further studies:

- The study should be replicated in another geographical area in Ghana to ascertain if geographical location has an effect on the acquisition of laboratory facilities.
- This study focused on category C senior high schools in the central region of Ghana. Different categories of schools such as category A and B should be studied to determine the availability and utilisation of laboratory facilities.
- Junior high school level should also be investigated for the availability, functionality and utilisation of integrated science laboratory facilities.
- There is the need to carry out similar studies in the post-secondary institutions, that is Colleges of education, Polytechnics, Universities and Research institutions.

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APPENDICES

APPENDIX A

BIOLOGY LABORATORY FACILITIES CHECKLIST FOR THE TEACHERS

Dear Respondent,

The data to be collected using this checklist is to find out whether the following biology facilities/ equipment are available for the teaching and learning of biology in your school. The data will be strictly used for the purpose of this research.

Name of School………………………………………………………………….

Area of Specialization……………………………………………………………

Teaching Subject………………………………………………………………...

Teacher's Qualification: Tick HND ( ) Bachelor's Degree ( ) Master's Degree ()

Others (specify)

Sex: Male ( ) Female ( ).

Tick from the following options the appropriate position of under listed facilities in your school.

S/N	Laboratory facilities/equipment	Available	Unavailable
1.	Laboratory.		
2.	Measuring cylinder.		
3.	Skeleton (Model)		
4.	Dissecting Equipment.		
5.	Spring balance.		
6.	Mounted pictures.		
7.	Conical flask.		
8.	Rain gauge.		
9.	Laboratory funnel.		

10.	Biological kits.		
11.	Test tube and Racks.		
12.	Beaker.		
13.	Aquarium.		
14	Thermometer.		
15	Microscope.		
16	Anemometer.		
17.	Wind vane.		
18.	Magnifying glasses.		
19.	Dropping pipette.		
20.	Bunsen burner.		
21.	Model for eye.		
22.	Model for heart.		
23.	Reagent for food test		
24.	Biological garden.		
25.	Preserved specimen		
26.	Plant press.		
27.	Binoculars.		
28.	Tripod stand.		
29.	Fire extinguisher.		
30.	Round bottom flask		
31.	Flat bottom flask.		
32.	Demonstration table and chair		
33.	Petri dish.		
34	Prepared slides.		
35.	Filter paper.		
36.	Quadrat.		
37.	Water bath.		
38.	Punnet square.		
39.	Fish trap.		
40.	Sweep net.		
41.	Drying oven.		

42.	Vacuum flask.		
43.	Herbarium Cabinet.		
44.	Mosquito net		
45.	Incubator.		
46.	Gloves.		
47.	Photometer.		
48.	Refrigerator.		
49.	Hand lenses.		
50.	Filter paper.		
51.	Bags (Polythene).		
52.	Cotton wool.		
53.	Furniture.		
54.	Table and lockers.		
55.	Evaporating dish.		
56.	Side shelves.		
57.	Pre – room/ special room.		
58.	Empty/plain slides.		
59.	Flash card.		
60.	Overflow Can.		

APPENDIX B

QUESTIONNAIRE ON FACTORS THAT AFFECTS THE EFFECTIVE USE OF LABORATORY EXERCISES

Choose the factors that hinder the effective use of biology laboratory resources in teaching biology in your school.

S/N	Listed Factors	Yes	No
1.	Lack of teachers' motivation (incentives)		
2.	Lack of adequate laboratory equipment and materials		
3.	Too much work load on teachers		
4.	Lack of laboratory attendant		
5.	It is time consuming		
6.	Large class size		
7	workshops are not organised for teachers to enhance further studies		

APPENDIX C

QUESTIONNAIRE ON THE UTILIZATION OF BIOLOGY LABORATORY FACILITIES

Instruction: Please answer all questions. You are requested to read each statement and sincerely provide the required information. The information provided will be strictly used only for this study.

Part A is personal Data, in part B, Yes or No is provided beside each statement. You are to respond by ticking the option that applies.

PART A

Name of School………………………………………………………………………..

Area of Specialization…………………………………………………………...…..

Teaching Subject………………………………………………………..…………...

Form…………………………………………………………………..…………...…..

Teacher's Qualification: Tick HND ( ) Bachelor's Degree ( ) Master's Degree ( ) Others (specify)

Sex: Male ( ) Female ( ).

PART B

Survey research questionnaire on utilisation of biology laboratory facilities.

S/N	Questions	Responses	
		Yes	**No**
1.	Does the school have biology laboratory?		
2.	Do you use biology laboratory equipment for practical work?		
3.	Has practical been conducted this term?		
4.	Are there available equipment in your laboratory?		

5.	Is the laboratory conducive or safe enough to carry out biology practical?		
6.	Are the equipment replaced immediately when broken or missing?		

7. Do you improvise materials that are not available in the laboratory for practical activities?
8. Does the practical work facilitate effective teaching and learning?
9. Does practical work influence students' academic performance?

PART C

Survey research questionnaire on exposure of students to biology laboratory exercises

S/N	Questions	Responses	
		Yes	No
1.	Does each of your students handle laboratory equipment independently during practical?		
2.	Do your students conduct practical work in groups?		
3.	Do your students cooperate during practical session?		
4.	Do students engage themselves effectively in the practical work?		

APPENDIX D

Level of Availability of Biology Laboratory Facilities in Category C Senior High Schools in Central Region

		Availability of Biology Laboratory Facilities/Equipment			
S/N	**Schools**	**Number of Facilities Available**	**Total no of expected facilities**	**Percentage (%)**	**Remark**
1	Bontrase SHTS	19	60	31.67	Inadequate
2	Awutu Bawjiase Comm. Sch.	24	60	40.00	Fairly adequate
3	Obrachire SHTS	12	60	20.00	Inadequate
4	Odupong Com. Day Sch.	24	60	40.00	Fairly adequate
5	Awutu Winton SHS	31	60	51.67	Adequate
6	Senya SHS	39	60	65.00	Adequate
7	Enyan Maim Com. Day Sch.	10	60	16.67	Inadequate
8	Fettehman SHS	12	60	20.00	Inadequate
9	Gomoa Gyaman SHS	26	60	43.33	Fairly adequate
10	Gomoa SHTS	36	60	60.00	Fairly Adequate
11	Gyaase Comm. SHS	12	60	20.00	Inadequate
12	J.E.A Mills SHS	22	60	36.67	Fairly adequate
13	Jukwa SHS	28	60	46.67	Fairly adequate
14	Komenda SHS	34	60	56.67	Adequate
15	Kwanyako SHS	35	60	58.33	Adequate
16	Kwagyir Aggrey SHS	39	60	65.00	Adequate
17	Mando SHTS	19	60	31.00	Inadequate

18	Mankessim SHTS	36	60	60.00	Adequate
19	Moree Comm. SHS	12	60	20.00	Inadequate
20	Nyankumase Ahenkro SHS	25	60	41.67	Fairly adequate
21	Obiri Yeboah SHTS	23	60	38.33	Fairly adequate
22	Odoben SHS	33	60	55.00	Adequate
23	Swedru Sch. Of Buss.	25	60	41.67	Fairly adequate
24	Abakrampa SHTS	17	60	28.33	Inadequate
25	Potsin T.I Ahm. SHS	38	60	63.33	Adequate
26	Abeadze State College	26	60	43.33	Fairly adequate
27	Aburaman SHS	26	60	43.33	Fairly adequate
28	Agona Fankobaa SHS	32	60	53.33	Adequate
29	Assin Manso SHS	29	60	48.33	Fairly adequate
30	Assin North SHTS	34	60	56.67	Adequate
31	Assin Nsuta Agric. SHS	35	60	58.33	Adequate
32	Assin State College	27	60	45.00	Fairly adequate
33	Ayanfuri SHS	20	60	33.33	Fairly adequate
34	Biesease SHS/Com	14	60	23.33	Inadequate
35	Brakwa SHTS	12	60	20.00	Inadequate
36	College of Music, Mozano	9	60	15.00	Inadequate
37	Dunkwa SHTS	19	60	31.00	Inadequate
38	Effutu SHTS	18	60	30.00	Inadequate

39	Eguafo-Abrem SHS	23	60	38.33	Fairly adequate
40	Enyan Denkyira SHS	28	60	46.67	Fairly adequate

Source: Researcher's Field Work, 2021