UNIVERSITY OF EDUCATION, WINNEBA

CHALLENGES OF TEACHING AND LEARNING BIOLOGY IN SELECTED SENIOR HIGH SCHOOLS IN THE EASTERN REGION, GHANA

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

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DECLARATION

Student's Declaration

I**, SOPHIA ANGMORKWOR KORLI,** hereby declare that this thesis, with the exception of quotations and references contained in published works which have all, to the best of my knowledge, been identified and acknowledged, is entirely my own work, and that it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE: ……

DATE: ……

Supervisor's Declaration

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

NAME OF SUPERVISOR: DR. JOHN EKOW MBIR AMOAH

SIGNATURE: ……

DATE: ……

DEDICATION

I dedicate this work posthumously to the memory of my late father Mr. Robert Tettey Korli, whose life, admonishing and encouragement were a valuable resource to me in this journey.

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ABSTRACT

This study examined the challenges associated with teaching and learning biology across selected schools in the Eastern Region, Ghana. Data were obtained from 26 biology teachers and 450 students across the schools. The questionnaire served as the primary tool, but an interview guide and checklist for observations were also used. With guidance from the research supervisor, the content validity of the primary instrument was established. The 90 public senior high schools in the Eastern Region made up the target population. Using stratified random sampling methods, 16 senior high schools from the assessible population were selected for the study. These schools are in six districts namely New Juaben North, New Juaben South, Upper Manya Krobo, Lower Manya Krobo, Akwapim North and Akwapim South Districts. Thematic analysis was employed for qualitative data while SPSS was used for quantitative data analysis. Findings from the study reveal some key challenges. The thematic analysis revealed challenges with the availability of resources, the emphasis on theoretical instruction, engagement and interest of students in subject and teacher related issues. Suggestions for addressing these challenges included the provision of resources, orientation with regards to instructional methods, teacher motivation among others. This paper represents an insightful reference for stakeholders with regards to the nature of the challenges biology education in senior high schools encounters and how these can be remedied.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter involves background of the study, statement of the problem, the purpose of the study, general objectives and specific objectives of the study, the research questions (questions that guided the study) and research hypothesis, the educational significance, the limitations and delimitation of the study.

1.1 Background of the Study

According to Kamarainen & Grotzer (2019), science activities involving organized knowledge concerning natural phenomena. This practice uses observation and experiment to describe and explain natural phenomena. Pye, Bertin, Lokey and Linington (2017) argues that this system describes and explains natural events via experimentation and observation. The Latin word scientia, which means knowledge, is the root of the word science, which has to do with nature. It is a systematic business that creates and arranges knowledge about the cosmos in the form of useful explanations and production. nations are considered to rely on science as a vast enterprise in order to advance technologically. Science is thus given emphasis in education because of its importance and connection to life and society.

The term “biology” (from the Greek “bios” for life and “logos” for study) refers to the branch of science that focuses on the attempt to understand living organisms and their biological stages. It encompasses every facet of the study of living things, including their appearance, classification, ecology, economic value, external shape, organization, internal structure, nutrition, health and other bodily functions, as well as their reproduction, life histories, heredity and origins. The terms “life science” or “biological

sciences" are frequently used in place of "biology" due to its broad scope and multi-disciplinary nature. The 'Father of biology' is Aristotle. Lamarck is credited with coining the term "biology". Botany, zoology and microbiology are the three main subfields of biology. Taxonomy, morphology, anatomy, cell biology, molecular biology, physiology, ecology, and genetics are some of its other disciplines.

The fundamental unit of life, the cell, is studied in cellular biology, while the basic chemistry of life is examined in biochemistry. Molecular biology studies the intricate interactions systems of biological molecules, and physiology investigates the physical and chemical functions of the tissues, organs, and organs of facts and presentation of information about the natural world.

The study of biology, a branch of science, is required in many academic disciplines and significantly advances a wide range of fields, including those involving the comprehension of the natural world and effectively using its advantages for human benefit (Abdussemiu, 2022). These fields include nursing, biotechnology, forestry, and agriculture (Tholey, Taylor, Heazlewood & Bendixen, 2017). As a result, the study of biology in senior high school can provide students with practical ideas, theories and concepts that will help them meet the obstacles both before and after graduation. According to Okeke (2000), there is a positive correlation between students' performance in biology and their propensity to successfully pursue science related professions as students who did well in biology could have prospects of becoming medical doctors, nurses, pharmacists, dentist, biology teachers, medical technologists, and food technologists, among others. The science of biology is distinct from other science fields in that it employs specific philosophical ideas and methods. For teachers to effectively and efficiently teach biology to students and for that learning to be

relevant, they must have a thorough understanding of the particular structure of biological knowledge, concepts, and methodology (Adegboye, Bello & Abimbola, 2017)

1.2 Statement of the Problem

A perusal of previous studies into biology education in the senior high schools in Ghana paint a picture of a growing concern about how teaching and learning of biology is done (Ackon, 2014). The concerns have to do with the inability of teachers to provide practical tuition of the subject in some schools due to a lack of science laboratory infrastructure or the instruments and materials necessary for practical biology lessons. These studies assert that biology teachers are left with no option but to resort to providing students with a theory-based approach to learning. A number of challenges arise from this approach which has to do with the difficulties encountered in providing theoretical instruction on a subject which is largely practical and thus requires demonstration for students to adequately taught and equipped to write examinations. On their part, students develop a negative attitude towards the study of biology due to the difficulty of relating to the theoretical approach of instruction adopted. This in turn results in a drop in the academic performance of students in biology (Tordzro, Asamoah & Ofori, 2021). This study thus intends to explore the state of biology education in some selected schools in the Eastern Region of Ghana and investigate the nature of approach and challenges therein for both biology students and teachers.

1.3 Purpose of the Study

The primary goal of the study is to examine the difficulties associated with teaching and learning biology at a few chosen senior high schools in Eastern Region. Researchers want to learn about the infrastructure's state, the approaches and methods

used, and the difficulties teachers and students have teaching and learning of biology the senior high school.

1.4 Objective of the Study

The study main goal is to identify the difficulties in biology instruction and learning in selected senior high schools in the Eastern Region of Ghana.

The study will be guided by the following specific objectives:

1. Examine the infrastructure for teaching biology in the senior high schools in the Eastern Region.
2. Identify the methods biology teachers at senior high schools in the Eastern Region use to teach and learn biology.
3. What difficulties do biology instructors and students have in teaching biology in the senior high schools?

1.5 Research Questions

The following questions guided the study

1. How is the infrastructure for teaching biology in senior high schools in the Eastern Region, Ghana?
2. How effective are biology lessons taught and how are students taught in taught in the Eastern Region?
3. What difficulties do biology instructors and students have in teaching biology in the senior high schools?

1.6 Research Hypotheses

The researcher developed the following research hypotheses in order to successfully complete the investigation:

1. Resources available in teaching biology would positively influence activities that occurs in biology class
2. Students would experience more of teacher -students centered interaction than student-Student centered, teacher-Resources centered and student-Resources Centered
3. Students would report experiencing more challenges in pursuing biology

1.7 Significance of the Study

The study will be important in providing crucial information about the state of biology education in senior high schools within the Eastern Region, with a focus on the difficulties faced by both teachers and students, school administration, the education service as well as policy makers in science education. The development of policies, the development of capacities, and the supply of infrastructure in line with the objectives of scientific education would all benefit from such knowledge.

Another significance of this study is that the knowledge that will be gained from it as well as similar studies will influence the approaches or modules adopted by teachers in biology education. Concepts gleaned from the study will contribute to enriching the quality of teaching practice, training syllabi and course materials.

Finally, this study and its findings will add to the body of knowledge in the domains of senior high school education STEM education and biology education within the larger fields of science.

1.8 Limitation of the Study

All the senior high schools in the Eastern Region offering Elective Biology should have been included in the study, however due to budgetary restrictions and other resource constraints, such as lack of time, only a few senior high schools were included. It is also possible that some respondents might respond incorrectly as information they provide cannot be traced back to them. The difficulties in teaching and learning biology would be highlighted by frequent visits to monitor the instructional sessions which might also increase the trustworthiness of the results.

1.9 Delimitation of the Study

Elective biology students and teachers from the chosen public senior high schools in the Eastern Region would be the focus of this research study. Only SHS 2 elective biology students would be chosen to take part in this research. This is due to the fact that SHS 1 students have just recently been admitted and may not have had time to study many biology-related topics. In addition, they would be on vacation during the period designated for data collection for this research. Students in SHS 3 were writing their mock exams and getting ready for their final WASSCE exam.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter reviews early research and authoritative writings that are relevant to this study. It focuses on the difficulties with biology teaching and learning. It also covers the theoretical and conceptual framework of this study.

The following criteria will be used to evaluate the literature: biology instruction, infrastructure for biology education and learning is available, methods of instruction used in biology that offers important insights into how learning actually occurs, particularly with reference to the difficulties of teaching and learning biology and other natural sciences. The section will also discuss the results of some similar studies that examines students' attitudes about biology education and how the knowing these views might lead to an appreciation of the current study.

2.1 Theoretical Framework

This study is built on the theory of constructivism as explained by Jean Baptist Piaget and Vygotsky. This theory is normally attributed to Jean Piaget who explained the mechanism by which knowledge is internalized by students. A learning theory called constructivism was created based on the idea that children think differently than adults. It claims that kids pick up new skills through adaption. Children actively construct meaning, test out theories, and attempt to understand the world and themselves rather than being passive consumers of knowledge. Constructivism is a learning philosophy based on the idea that we create our own understanding of the world we live in by reflecting on our experiences. Each of us creates their own "rules" and "mental models," which we use to interpret our experiences. So learning is basically the act of changing

our mental models to account for new information.

According to Piaget, through the process of accommodation and assimilation, individuals construct their own knowledge from their experiences and during assimilation they incorporate the new experiences without changing the already existing frame work. The theory of constructivism holds that:

a. Learning outcomes are influenced by the learner's knowledge as well as the learning environment;
b. Learning entails creating meaning.;
c. The development of a meaning is significantly influenced by the existing knowledge;
d. The meanings created are assessed and are given the option to be approved or rejected;
e. There are patterns in the types of meanings pupils construct due to shared experiences with the physical world and through their natural language (Bennett, 2002; Vygotsky, 1978).

Piaget explores four sequential stages of the psychological development of the young learner and believes teachers should be cognizant of these stages. During the Sensory-motor Stage, (before the age of 2) sensory experiences and motor activities dominate. Lev Vygotsky, known for his theory of social constructivism, believes that learning and development is a collaborative activity and that children are cognitively developed in the context of socialization and education. The perceptual, attention, and memory capacities of children are transformed by vital cognitive tools provided by culture, such as history, social context, traditions, language, and religion. For learning to occur, the child first makes contact with the social environment on an interpersonal level and then

internalizes this experience. The earlier notions and new experiences influence the child, who then constructs new ideas. For Vygotsky, the zone of proximal development, that is "the distance between the actual development of a child as determined by the independent problem solving, and the level of potential development as determined through problem solving under adult guidance or in collaboration with more peers (Vygotsky, 1978)".

This theoretical framework is relevant because it explains why pupils would struggle to comprehend complex biological concepts because their complexity has nothing to do with what they already know. The learner's prior knowledge and previous interactions with the learning environment have a role in how meaning is constructed. The students' previous learning environment would be regarded to exclude the sophisticated biological terms and concepts, such as genetics, the nervous system, and other related concepts. There is a lot of research to back up the idea that kids make up their own explanations for scientific occurrences, and that these explanations can be different from the ones that are generally accepted in the field. This has been shown to be true in the following contexts: photosynthesis, respiration, biological classification, and evolution (Ozer, 2004).

In Piagetian classroom a variety of activities must be provided to challenge students to accept individual differences, increase their readiness to learn, discover new ideas, and construct their own knowledge. Concrete learning experiences, such as drawing, drama, model building and field trips that involve hands-on opportunities to see, hear, touch, taste, and smell are essential.

A Vygotskian classroom emphasizes creating one's own concepts and making knowledge one's property; this requires that school learning takes place in a meaningful

context, alongside the learning that occurs in the real world. As seen earlier in the Piagetian classroom, this model also promotes the active participation and collaboration of distinctive learners. The Vygotskian classroom stresses assisted discovery through teacher-student and student-student interaction. Some of the cognitive strategies that group members bring into the classroom are questioning, predicting, summarizing, and clarifying.

Constructivism transforms the learner from a passive recipient of information to an active participant in the learning process. Guided by the instructor, learners construct actively their own knowledge rather than just mechanically ingesting knowledge from books. The principles of the philosophical stream of constructivism offer the ideological background that will help instructors to create learner-centered and collaborative learning environments that aim at the development of critical thinking from learners and learning through experience. Of course, the role of the instructor should be mediatory, not the one of authority. The instructor should be very interested in the interaction of the teaching content with the needs and abilities of every learner, and not just the completion of the curriculum (Triantafyllou, 2021)

2.2 Conceptual Framework

The Conceptual Framework depicts the relationships between independent and dependent variables are the variables (Figure 1). Instructional materials, teachers' teaching style, students' attitude, students learning style and nature of biological concepts serve as the study independent variables. The dependent variable is the factor that is seen and measured in order to determine the independent variable's influence. Biology Teaching and Learning Difficulties is the study's dependent variable (Figure 1).

Independent variables- **Dependent variable**

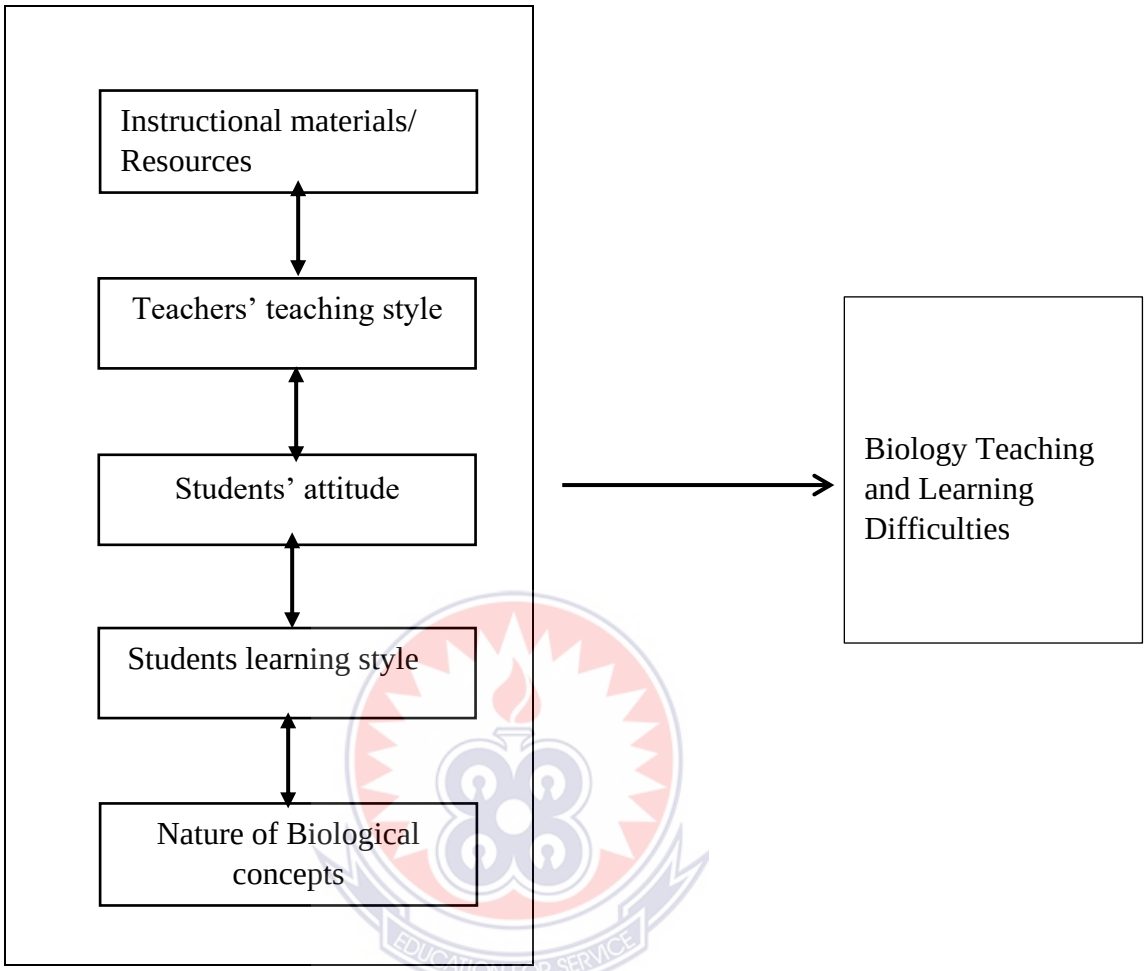

Figure 1: Conceptual Framework (Borich, 2007)

Teaching that successfully facilitates students' learning, as intended by the teacher, is considered effective. In essence, effective teaching consists of just two basic components: clear communication and engaging instructions (Stronge, 2007). The teacher as a result is required to be very explicit regarding what types of learning that will be encouraged. This is accomplished by setting up and delivering a learning experience. Conceptualizing what good teaching is has been directed in a plethora of approaches over the years. Research on the best ways of teaching up to the 1960s was mostly focused on attempting to pinpoint teacher characteristics, such as personality

qualities, sex, age, education, and training, that would have an impact on their efficacy. Cattell, for instance, asked 254 individuals, including education directors, teacher trainers, schoolteachers, and students, to list the most crucial characteristics of a successful teacher in 1931. Overall, personality and will, intelligence, sympathy and tact, open-mindedness, and a sense of humor were the five traits most frequently reported.

Studies that tried to link these teacher traits with student academic performance have occasionally been referred to as or called "black-box" studies in the past. The claim is that studies on effective teaching mainly ignored what actually happened in the classroom. Instead, it focused solely on the characteristics of the input (such the characteristics of the teacher and students) and the output (like exam results), then tried to relate the two. The majority of research on effective teaching, however, has clearly and unmistakably focused on classroom activities since the 1960s, notably the relationships between the teacher and students. There is at present widespread acceptance on the fundamental framework for our thinking about effective teaching, within which we may make a significant contribution. Additionally, since the 1990s, a higher priority has been laid on constructing an empirical proof base for effective classroom practices and using this to support teachers' initial and ongoing professional development.

Context variables are all those elements of the learning activity's context, which is often a classroom lesson, that may have an impact on the learning activity's success. The qualities of the learning tasks and activities themselves, as well as how these interact with one another, are all considered to be process variables. Process variables refer to what really occurs in the classroom and deal with the views, techniques, and behavior

of the teacher and students. These factors include, among others: the teacher's enthusiasm, the clarity of their explanations, the use of questions, the use of praise and criticism, management techniques, disciplinary methods, the atmosphere in the classroom, the lesson plan, the appropriateness of the learning tasks, the type of feedback students receive, the level of student participation in the lesson, student-initiated interactions with the teacher, and the students' learning strategies.

Product variables are all the desired educational outcomes that serve as the foundation for instructors' lesson design and the standards they or others use to assess efficacy. It would seem that greater knowledge and abilities, increased interest in the subject or issue, increased intellectual motivation, increased academic self-confidence and self-esteem, increased autonomy, and increased social development are the most crucial educational outcomes for students. Tests can measure many of these outcomes, but other measures, like the teacher's judgment, are frequently used for others. Unfortunately, it's sometimes difficult to measure these consequences, thus one should exercise caution while using these methods.

Almost all research on effective teaching reported over the past few decades has been based on this general framework of Context-Process-Product (Borich, 2007; Muijs & Reynolds, 2005; Ornstein & Lasley, 2004). Such study has brought up a number of crucial issues relating to our comprehension of these three types of variables as well as how research might show how various elements of the educational environment contribute to effectiveness. When taking into account context factors, it is evident that there is a plethora of elements to the context of a teaching situation that could affect its success. These factors can be combined in countless different ways to precisely define a given setting. In a large metropolitan secondary school, a top-ability group of 16-

year-old students studying science might be taught about electrolysis in the context of a session on adding little numbers for a mixed-ability class of five-year-old students. Choosing which context-relevant factors should be taken into account when determining the best learning activity is a significant problem for teachers. It is obvious that the multiplicity of instructional environments presents challenges for study.

First of all, this limits the number of context-related factors that can be considered at once in any study. Second, which additional factors are present may affect how one variable affects efficacy. Therefore, the size of a school, for instance, may have a different impact in a wealthy neighborhood than in a community with a lot of poverty (Borich, 2007). When taking into account process variables, it is once more evident that there are numerous elements of classroom activities that could very well be connected to efficiency. Researchers have also faced a variety of challenges when determining the most effective ways to recognize, track, and document the numerous facets of student and instructor behavior as well as learning activities. There are research issues related to the use of questionnaires, interviews, and classroom observations that call for extreme caution in the interpretation of the data gathered (Mujis & Reynolds, 2005). This can enrage educational policy makers, who frequently desire straightforward responses to the inquiries they make regarding the efficacy of educators and instructional strategies. However, the plethora of studies on effective teaching that have been carried out over the past few decades have now clarified the fundamental nature of the numerous process variables involved in teaching, ranging from very discrete observable behaviors (like the frequency with which teachers use praise) to more general and more subjectively assessed qualities (like classroom ethos). Such studies have emphasized the significance of considering how classroom activities affect both students and teacher (Ornstein and Lasley, 2004). In order to determine if effective

teaching occurs, attention has been paid to how teachers and students perceive one another's behavior and the current activities.

How can we determine whether effective teaching has taken place when taking product variables into account? Effective teaching primarily focuses on a teacher's ability to successfully facilitate the targeted student learning through a particular educational activity. The issue that arises from this is that there is very little agreement on how important each of the several educational outcomes is that are considered to be the objectives of good instruction. Effective teaching aims can be short-term (achievable by the end of a lesson) or long-term (achievable at the end of a course or even later), and they can emphasize either cognitive (intellectual) or affective (social, emotional, and attitudinal) aspects of learning. If assessment is even conceivable, they might be amenable to objective monitoring and assessment or they might involve subjective monitoring and assessment (Cullingford, 2003).

There is an additional challenge when taking educational outcomes into account. We must consider the fact that teachers nearly always seem to be planning lessons with a variety of outcomes in mind. Additionally, this set of results will change from session to lesson and even within a lesson depending on the needs of each student in the class. For instance, when addressing a student's response to a question, the instructor may consider that student's lack of confidence and may act toward that student somewhat differently than toward another student providing a similar answer. It may be difficult for an observer to comprehend the teacher's behavior when it appears inconsistent.

Many research investigations have focused on the most readily available, trustworthy, and well-respected measures of educational attainment, particularly standardized attainment tests and national examinations, as a result of the difficulties in converting

educational objectives into product variables. The idea that intellectual achievement as demonstrated in such exams and examinations is the most crucial educational outcome has thus been encouraged and supported by such a development. Such a presumption is not only inconsistent with the stated educational goals of many professors, but it also gives such assessments and examinations more academic legitimacy than they truly merit. For instance, the validity of standardized subject achievement assessments as measures of effective instruction is questioned. Since they are intended to measure progress in a particular subject area, there will be significant variances amongst students that have little to do with the effectiveness of the instruction because they will not have studied the same material at the same pace or in the same depth. The fact that some teachers are skilled at preparing students for the test by paying close attention to the type and structure of the questions and the mark schemes utilized as well as by providing frequent practice with identical test material is another significant drawback of such exams (Haydn, 2007).

This may raise students' achievement scores above their actual, underlying level of topic knowledge and proficiency (Galton, 2007). The validity of national examinations as a gauge of effective teaching is also questioned due to issues with comparability among examinations created by various examination bodies and the influence of school and teacher policies on course offerings, student selection for courses, and examination entry. Additionally, there may be a discrepancy between the teacher's perception of effectiveness and the results of the tests. For instance, a teacher might believe that one of the key learning objectives of science instruction is for students to gain a solid knowledge of what constitutes a scientific experiment. However, the school's exam may not provide much credit for such comprehension and may place more emphasis on factual information. All teachers are thus forced to choose between what they believe

to be the most important educational results they wish to encourage and the outcomes anticipated by others with an interest in the process. It's important to keep in mind that researchers have used a variety of terms to describe teachers, including "the good teacher," "the successful teacher," "the teacher I like best," and "the teacher I learn most from" when analyzing the relationship between the idea of effective teaching and product variables. One needs to be careful when combining the findings of such investigations because each of these terms has a somewhat distinct meaning. Several studies have investigated how students perceive teachers and instruction (Cullingford, 2003; Haydn, 2007; Pollard, Triggs, Broadfoot, McNess, Osborn, 2000). Overall, the picture that has emerged shows that students see a good teacher as someone who organizes the learning environment, clarifies the work that needs to be done, assists you with it, and is nice and encouraging.

Additionally, effective teachers are frequently described by students as using a variety of teaching strategies and learning activities, employing a variety of techniques to keep students interested and quickly resolve discipline issues, and managing the lessons to keep students focused on what the teachers want them to do. We must now clearly distinguish between "effective teaching" and other phrases that are used frequently but have similar meanings. Whether the instruction is actually producing the desired results is fundamental to good teaching. Identifying what genuinely works in education requires looking at results. The idea of effective teaching stems from a psychological way of approaching the subject, where the focus is on finding classroom behaviors that can be observed and connected to measurable results. Contrarily, adjectives like "good," "liked," and "preferred" teaching emphasize the observer's impression of the instruction and typically focus on aspects of instruction that the observer deems desirable without necessarily making a direct connection to results.

As was previously mentioned, a fundamental framework of Context-Process-Product has been used in practically all research on successful teaching that has been published over the past few decades. The studies that have attempted to use this framework to investigate effective teaching are examined in this section. In doing so, emphasis will be placed on the two primary research approaches that have been used and that make up the vast majority of study. Process-product studies, the first strategy, tried to link process factors to product variables; process studies, the second strategy, concentrated almost exclusively on process variables.

Many researchers have tried to look into different aspects of effective instruction. Studies based on participant observation of classroom activities, teacher assessments of good teaching, student assessments of effective teaching, and studies based on outside observers' observations of classrooms, Studies based on participant observation of classroom activities, teacher evaluations of effective teaching, student evaluations of effective teaching, and studies based on outside observer classroom observations. Process-product studies have dominated the study of successful education for many years. As a result, a substantial database with many of the teaching attributes emphasized in student teachers' textbooks was developed. Typically, these studies use classroom observation to record the frequency of occurrence of various teacher behaviors and components of teacher-pupil relationship (the process variables), and then investigate how they were associated with the efficacy requirements being used, such as increases in standard subject achievement tests (the product variables). The most common approach to examining this connection is to simply compare the process variables to the outcome variables in the hopes that the strong correlations will reveal the elements of instruction that have the greatest impact on efficacy.

However, a number of studies have used an experimental design recently to contrast students who were taught one way with students who were taught another. Reviews of process-product research often include 10 qualities of effective teaching (Good & Brophy, 2003; Petty, 2006; Stronge, 2007). They are explained as follows. Clarity of the teacher's explanations and directions establishing a task-oriented classroom climate making use of a variety of learning activities. Establishing and maintaining momentum and pace for the lesson encouraging pupil participation and getting all pupils involved monitoring pupils' progress and attending quickly to pupils' needs delivering a well-structured and well-organized lesson providing pupils with positive and constructive feedback. Ensuring coverage of the educational objectives. Making good use of questioning techniques.

Such process-product investigations, however, face two significant issues. They start by using a straightforward research strategy, making an effort to concentrate on brief, discrete, observable behaviors that are afterwards connected relatively independently with the product characteristics. The notion that, for instance, discrete behaviors like "use of praise" or "repeating questions" can be studied separately from one another and everything else taking place during the lesson, and that each will contribute in its own separate and identifiable way to effectiveness, is very dubious and has contributed to a large body of contradictory data. The second important issue is that such a research design is unable to distinguish between classroom activities that merely take place while effective teaching is taking place and activities that, by themselves, are successful teaching. Numerous process-product studies have made an effort to address the issue of focusing on too many separate behaviors by combining these to describe specific teaching philosophies. These studies have sought to determine if particular teaching methods are more effective (and, if so, in what circumstances and with regard to what

results). However, the usage of teaching techniques by teachers has been extremely variable, frequently switching from one style to another within a single lesson. This has made studies examining teaching styles problematic. Additionally, some professors might employ a certain style well, while others might employ the same style incorrectly. This has made it incredibly challenging to draw any logical conclusions about the efficacy of various teaching methods, and the discussion surrounding this is still very contentious.

Process-product studies also have issues with the variety of instructional contexts and intended outcomes. For instance, teaching mathematical formulas to 15-year-old students as determined by a memory test may be substantially different from teaching creative writing to 7-year-old students as determined by project work. As a result, even while we have some broad concepts of what functions well overall, this may not serve as a reliable guide for what would function well in a particular teaching circumstance. Numerous researches have concentrated on very particular learning areas to address this issue, from the teaching of reading in primary schools to the teaching of historical empathy in secondary schools. When compared to research that deal with very broad generalizations, this more specialized approach to the study of successful teaching frequently provides more insightful conclusions.

Instead of connecting process variables to product variables, process studies have attempted to investigate successful teaching by tying process variables to one another. Within this method, there have been two significant developments. The first evaluates lesson effectiveness using a few elements of student behavior. The second focuses heavily on the perceptions and assessments of those engaged, whether they be the teacher, the students, or the observer, in order to determine effectiveness.

The first method shares many characteristics of process-product studies, but instead of using product variables, it focuses on student behavior during the session (such as how hard and engaged the students work, or how long they spend on task). The advantage of this strategy is that it makes it simpler to find connections between student behavior connected to learning and teaching. Its flaw is that it's difficult to tell whether behavior that seems to be related to learning is truly leading to the desired learning results. Indeed, students are skilled at appearing to be focused and working hard when they are not.

The second strategy, which incorporates the opinions of teachers and students, has also been successful. It has particularly highlighted how important it is to comprehend why a session was successful or unsuccessful to consider how teachers and students perceive one another and the learning activities. In fact, a number of classroom observation techniques have been used in several studies to clarify classroom procedures by watching lessons and then speaking with the teacher and students afterwards to find out their opinions of the lesson. These investigations have made it possible for observers to analyze the effectiveness of a lecture more effectively than would have been possible if they had relied solely on observational data. The depth with which the teachers discuss their choice of instructional strategies and how they changed what they were doing to account for the lesson's progression is frequently what makes such research particularly fascinating. Examining the typical challenges students encounter while learning a given subject is an important aspect of research on successful teaching. Such studies have examined highly particular subjects (such as long division and radioactivity) in an effort to spot common mistakes. Effective teachers have developed an understanding of these issues, and because of this, they can help their students avoid these challenges when learning these particular topics. The extent to which excellent

teaching may lead to higher levels of educational achievements than are attained by less effective teaching is another crucial question.

The aptitude, motivation, socioeconomic class, and prior level of achievement of students have been cited by several scholars as the primary factors of educational attainment. They contend that the differences between learning from a teacher who is more effective vs a teacher who is less effective are negligible in comparison. It has already been stated that it is challenging to determine the exact causes and effects of good education. The difference between research on "teacher effects" and research on "effective teaching" must be kept in mind, though.

The main focus of research on teacher impacts is how much having diverse teachers may help to explain some of the disparities in educational achievement between students. Contrarily, research on effective teaching focuses on the overall level of educational attainment that is encouraged by instruction and aims to identify those teaching strategies that are effective, even if they are employed by the majority of teachers and thus are unable to account for variations in students' final levels of achievement. Although there is considerable overlap between the research on teacher effects and good teaching, the fact that there are numerous factors that affect students' academic performance should not be used to minimize the critical role that great teaching plays in fostering student learning. The attempt to examine the best available research evidence regarding which activities, programs, and practices have the greatest positive impact on learning outcomes for students has been a significant development in research on effective teaching. This strategy has led to a number of "systematic reviews" of the research literature that have been requested by governments and other organizations to serve as a foundation for the creation of policies and practices that are

consistent with the findings of the study. Through the publication of these findings on websites targeted at schools and instructors, these reviews are made broadly accessible. While there are many supporters of this strategy (Oakley, 2002; Slavin, 2008), it is crucial to remember that it is foolish to think that all teachers can adopt certain classroom practices in a mechanical fashion that will improve students' learning results. Rarely does research have clear consequences for how we teach. When teachers think about how to improve their own classroom practices, they must read any such syntheses of research information with intelligence. Therefore, it is important to proceed with care when reading the numerous publications that assert to provide a foundation for "evidence-based teaching" (Hattie, 2008; Petty, 2006; Stronge, 2007).

As previously mentioned, it's critical to consider the specific context of the learning activity (such as the type of school, subject matter, and level of attainment) as well as the specific educational outcomes desired (such as increased student academic self-confidence and exam success) when considering effective teaching. What elements of the learning process contribute to its success and how these elements have the effects they do are the subjects of effective teaching? Three methods of thinking about good teaching have arisen as a result of examining the "what" and "how" of effective teaching. In actuality, these three models work in concert and are congruent with one another. They each reflect one of three perspectives on the same phenomenon, but each has a different fundamental framework for elaborating on the important factors used. Each framework has a unique development history and unique insights to provide in the quest for a comprehensive understanding of effective instruction.

The first method of considering effective teaching is the surface level analysis. This methodology is mostly based on research and theoretical discussions on successful

teaching. Such a strategy has concentrated on two complementing conceptions that seem to be important efficiency factors. Active learning time (ALT), often known as academic learning time or "time-on-task," is the first construct. This is the amount of time students actively participate in the learning task and activities intended to produce the desired educational outcomes. The second concept is instruction quality (QI). In terms of presentation and suitability for achieving the targeted educational objectives, this relates to the caliber of the learning tasks and activities. In essence, model 1 says that increasing ALT and QI is the key to effective teaching (Galton, 2007; Wilen, Hutchinson, & Ishler, 2008). In his research of effective teaching in terms of "time management" and "classroom learning environment," Creemers constructed a model of educational efficacy that heavily relies on this distinction (Creemers & Kyriakides, 2008). The ALT framework has been gradually improved and complexified. Early studies focused on how much time students spent on tasks that would lead to outcomes, and they found that more time spent on task behavior was linked to higher educational achievements.

This was generally true regardless of whether it was the result of teachers devoting more instructional time to task behavior (for instance, primary school teachers devoting more time during lessons to basic number work) or of particular teachers being more successful at keeping students on task throughout the lesson. These studies frequently emphasized the time wastage that occurred during instruction that was deemed to be less successful (for instance, lessons where students had to wait for extended amounts of time to see a teacher or when discipline issues were permitted to interfere with the task at hand). Although some learning activities intended to foster specific educational outcomes (such as pupil autonomy or skills in using practical equipment) may appear to be time-consuming if the researcher is using another educational outcome as the

criterion of effectiveness, it is important to proceed with caution when considering the idea of time waste.

Later studies have made an effort to move away from the simplistic idea of "amount of time" and instead explore what it means to be "actively engaged." Being on task in the sense of paying attention to a teacher or completing a task, it is said, fails to account for the character of that experience. Some students seem to be fairly capable of completing the work without truly being fully intellectually and affectively engaged. The idea of being "actively engaged" signals a shift from the idea of keeping students occupied to the idea of developing and maintaining the right mental engagement with the learning activities necessary to successfully achieve the educational results intended. The distinction between ALT and QI is now more difficult to maintain. By highlighting the need of teaching and learning quality for effectiveness, the concept of QI complements ALT. It is obvious that a teacher who could maintain a high degree of on-task behavior but created bad learning experiences would not be successful. In essence, QI refers to how easily students may attain the desired learning outcomes as a result of the instruction.

This mostly entails evaluating whether the learning experience is set up in the most sensible and acceptable manner possible when the context is taken into account. There are two methods to go about this. by emphasizing the psychological components of training first. The second paradigm for considering good teaching is provided below and expands on this strategy. Second, by examining the attributes that seem to be significant in general. The third model for considering good teaching is provided below and expands on this strategy. One more, very important remark regarding the connection between ALT and QI must be stated, though, before getting to these two

models. The complimentary nature of these two conceptions has been emphasized. When considering effective teaching, it's critical to keep in mind that the great majority of classroom process variables have an impact on both ALT and QI. This is because to the fact that high QI often goes hand in hand with parts of teaching that maintain high levels of ALT. Although it is important to distinguish between these two structures, they shouldn't be seen as functioning separately.

The second way of considering effective teaching comes from an effort to pinpoint the key psychological factors at play. It represents an expansion of the surface level of analysis from a psychological standpoint, as was mentioned before. Because it makes use of the two core constructs of ALT and QI, which are the most important in terms of the widest conceptions of value, Model 1 has been referred to as a "surface level" of analysis. In conclusion, process variables affect ALT and QI, which in turn affect educational results. This might be thought of as a "surface level" explanation of effective instruction. The psychological aspect of analysis seeks to establish a causal relationship between the process variables and educational results by elucidating their impact in terms of the key ideas, principles, and processes involved. As a result, it provides a "deeper level" justification for effective teaching. The psychological level of evaluation makes an effort to clarify the psychological circumstances required for learning to take place. If specific process factors have an impact on learning outcomes, they must do so by affecting students' psychological states and thought processes. Such a strategy aims to justify this.

Effective teaching is based on a wide range of psychological ideas, beliefs, and procedures (Slavin, 2006; Woolfolk, 2007; Woolfolk, Hughes, Walkup, 2008). These include, among other things, focus, memory, processing of information, learning

transfer, reinforcement, feedback, motivation, ability, expectations, and self-concept. Ultimately, it seems that there are three key characteristics of student learning that must be taken into account when determining whether a teacher is effective; the pupil *attending* to the learning experience, the pupil must be *receptive* to the learning experience and the fact that the learning experience must be *appropriate* for the intended learning outcomes.

The pedagogical level of analysis is the third method of thinking about good teaching. It has mostly developed as a result of teacher educators' use of the perspective of effective teaching (Kerry & Wilding, 2004; Wragg, 2005). It focuses on the attempt to adequately describe the craft of teaching so that it will be useful to both beginning teachers and seasoned educators taking in-service courses. The focus of this perspective has been on describing good teaching in terms that practitioners can understand and that are relevant to their needs and concerns as professionals. Model 3 is based, to the greatest extent feasible, on how teachers themselves think and speak about their own teaching and how they counsel student teachers. This method primarily views education as a managerial activity and aims to pinpoint the key duties of instruction as well as the supporting management responsibilities necessary for efficiency. Following the publication of Kounin's (1970) landmark work on classroom management, this strategy has significantly influenced researchers. In contrast to less effective teachers, Kounin highlighted a number of managerial strategies utilized by effective educators, including "withitness," "overlapping," "smoothness," and "momentum." This study was particularly significant because it focused emphasis on components of teaching that, in people's subjective perceptions, were much more meaningful and significant than the process variables being studied at the time. Furthermore, these components swiftly gained respect from the research and teacher education organizations.

Since Kounin's study was published, two main development threads have been explored. First, there has been an effort to categorize the managerial tasks necessary for successful teaching in terms of key "teaching skills," with the implicit premise that these skills can be developed and encouraged within teacher education and that managerial tasks can be divided into such distinct component skills. These studies also provide a helpful distinction between general teaching abilities (such as being audible and controlling students and activities) and subject-specific teaching abilities (such as determining whether the subject matter, instructional strategy, and activity design are appropriate for the desired educational outcomes). Despite the fact that these two sets of abilities are complementary, the former emphasizes broad presentation and management skills, whilst the latter emphasizes the "intellectual packaging of the subject matter." The investigation of how teachers and students see and make sense of what takes on in the classroom, as well as how they perceive one another and the learning activities that take place, has been the second main thread of growth. This entails examining the connections between three elements of the instructional process in the classroom. These are teacher perceptions, strategies and behaviour, pupil perceptions, strategies and behaviour and then finally characteristics of the learning task and activities.

As a result of this research, it has become clear that both teachers and students have expectations regarding learning activities and that both have techniques for coping with the demands that each place on the other. According to studies on self-efficacy, which refers to people's views about their capacity to achieve their goals, both student and teacher self-efficacy have a significant impact on how both students and teachers act in the classroom (Bandura, 1997; Woolfolk et al., 2008). Thus, students may react to an activity far differently than the teacher anticipates. These issues are partly caused by

teachers making generalizations about students' levels of motivation, comprehension, and competency, and partially because students may just not grasp what they need to perform. Teachers must be aware of students' perspectives on their experiences with teaching and learning in order to reduce such issues. Although it may be seen to be at the core of many of the teaching abilities usually considered, this attribute of 'social sensitivity', that is the capacity to view things from another's perspective has received surprisingly little attention in thinking about effective teaching.

2.3 Biology Education

Biology is a branch of science that deals with the study of living things, including their structures, shapes, functions as well as heredity and other topics. Biology explains the existence of life. It provides the foundation for comprehending the intricate workings of an organism's body parts. According to Taiwo and Emeke (2014), biology introduces pupil to the world of self-knowledge as well as the nearby and faraway environment. The current objective of biological education is to create biologically and environmentally competent individuals who recognise the value of life as the highest good (Akmalovna & Olimovna, 2020).

The primary goals of teaching biology in secondary school are to encourage students, help them understand the fundamental ideas of biology, such as the cell, genetics, evolution, and ecosystems, and to help them develop their scientific literacy skills, such as critical thinking, problem solving, and scientific inquiry. This might be the reason it was included to Ghana's senior secondary school curriculum.

2.3.1 Infrastructural availability for the teaching and learning of biology

The primary focus of science is the study of natural events. Some issues in the subject are connected to the dearth of biological education infrastructure, including

laboratories. Buildings, playgrounds, ICT equipment, and educational resources help staff and students accomplish their objectives (Anaman, Zottor, & Egyir, 2022). Infrastructures are referred to as "buildings that make learning safe" by Hong and Zimmer (2016). Infrastructure in biology education could include things like classrooms, labs, reading rooms, libraries, etc. Laboratory experiments can be used to learn most skills.

Activities (that require special equipment) that are challenging to be carry out in typical classroom settings are done in laboratories, which are closed-off spaces. Understanding how and why strong educational accomplishment and enhancing school infrastructures should be prioritized is made possible by the high caliber of biology education infrastructure and the ability to provide an effective education notwithstanding historical changes (Assoumpta & Andala, 2020). Poor labs, libraries, and classrooms have the most an impact on students' performance, according to Tavares (2015). How effectively pupils are taught depends on the classrooms, laboratories, and educational found that poor classrooms, libraries, and labs affect student performance the most. The resources available for biology education. Without scientific laboratories, biology students cannot enroll in practical classes (Olufunke, 2012).

According to Allotey (2014) maintaining public high schools has a significant economic impact due to the size of the associated cost as well as the need to ensure that facilities are used as efficiently as possible. As a result, it is necessary evaluate the upkeep of the facilities used for biology instruction in senior high schools.

According to the literature on the topic, selecting the right teaching and learning resources is a crucial aspect of the teaching and learning process. According to Opara and Etukudo (2014), having instructional resources like specimens for biology lessons,

gives students the chance to use of their senses, specifically their senses of hearing, smell, sight, taste and physical touch.

2.4 Methods of teaching adopted in Biology

The methodology of teaching biology investigates the substance of the educational process in this topic as well as the patterns of how pupils assimilate biological material (Aminjonovich & Akmalovna, 2021). Regarding the methods employed, the teaching of biology as a topic is of outmost importance.

The most crucial strategies teachers use to achieve class objectives are teaching approaches (Rido, 2020). numerous educational teaching strategies improve students learning process. A teaching strategy must take into account both the learner's characteristics and the type of learning it is meant to facilitate in order to be effective. Ganyaupfu (2013) claims that teaching is a continual process that entails bringing about desired changes in students via the use of effective teaching strategies. According to Ganyaupfu (2013), teachers shoud apply the most effective teaching techniques for the lesson in order to affect the disired changes in the years, many different teaching strategies have been employed to teach science, but the following are the most noteworthy ones:

1. *Lecture-based method*
2. *Project-based method*
3. *Demonstration method*
4. *The Practical Hand-On Approach*

2.4.1 Lecture-based method

The lecture-based approach merely involves an oral presentation of the subject matter for learning (Mladenovic, 2000). The lecturer, instructor, or speaker typically delivers

this oral presentation to a group of people or students. It is characterized by one-way communication, with pupils listening and taking notes while the teacher speaks the majority of the time.

According to Kaur (2011) in practically all courses or learning sequences, the teacher is required to introduce concepts and information. He must introduce subjects, summarize has to present information and ideas. He has to introduce topics, summarise the key ideas of the learning activity, and encourage additional study. The employment of a lecture-based technique is necessary for all of these activities. The teacher has excellent control over time and materials while using this method, which is employed with a large number of students.

In a classroom lecture, voice, gesture, movement, facial expression, and eye contact can be used to enhance the information, according to White and Gardner (2013). Students to hear a variety of speaker and become accustomed to various language styles using the lecture-based method (Sally, 1985). In this regard, the lecture-based method has the following advantages:

1. *A subject can be presented from the correct angle and orientation, and the broad contours of its range can be revealed.*
2. *A great deal of information can be given quickly.*
3. *The lecture can greatly increase audience interest in the topic.*
4. *More attention could be attracted and kept since interest attracts attention.*
5. *The spoken word has more weight than a book's ineffectual appeal.*
6. *The language could be adjusted to be appropriate for all audience members.*

The lecture-based method of teaching has some disadvantages too. According to Prince (2004), the disadvantages include:

1. One-way communication by the teacher, without much engagement. Passive recipients of knowledge and may struggle to actively process and apply the information.

2. Lectures can be lengthy and monotonous. Students may lose interest or get distracted, affecting their ability to absorb and retain information effectively.

3. It can be difficult for teachers to address the individual needs and learning styles of each student.

4. It leaves little room for active learning activities such as group work, discussions or hands-on experiences.

5. Limited feedback and assessment

According to Udo, Nsit, Onyebuchi, and North (2021), the project-based learning technique is a student-centered pedagogy that combines a dynamic classroom approach. It is thought that by actively exploring challenges and problems from the real world, students gain a deeper understanding of those issues.

The project-based method can be characterized as student-centered instruction that takes place over an extended period during which students choose, plan, research, and then creates a product, presentation or performance that responds to a genuine issue or a respond to a real-world topic. Teachers typically act as facilitators, building up the process as it goes along and offer scaffolding, direction, and strategic instruction. In a project-based learning settings students should be free to explore and interact with their surroundings through their senses and, in a way, to guide their learning based on their interests. In a project-based learning environment, students work together to solve "purposeful" challenges while emphasizing democracy (Johnson, 2002).

According to this, students are seen as active agents who solve real world issues, generate knowledge, and interact dynamically with their environments to give themselves and the world around them meaning. One of the best ways to teach science is through projects since it gives pupils the chance to think critically and pursue independent learning. This suggests that students learn to prepare themselves for task at hand by using the project approach, which gives them the opportunity to identify the problem, plan their work, find appropriate resources to carry out their plans, and draw conclusions at the end.

2.4.3 Demonstration Method

A demonstration is a process of teaching someone how to make or do something in a step-by-step process as you show how, you "tell" what you are doing (Amaewhule &Chukwudi, 2020). Ivanova and Nwosu (2013) claim that teachers can participate in demonstration classrooms to assist them improve their teaching practices, which may or may not involve demonstration of a specific learning concepts. Despite the paucity of the evidence, studies indicate that the consequences of demonstration classroom teachers include a shift in the way teachers relate to students, more reflection on their teaching methods, and a greater sense of personal accountability for students' learning. With this approach, the teacher plays the lead role while the students observe and take the initiative later. A demonstration is an action that provides proof or evidence to support a claim. It is clear from the term that the goal is to demonstrate and describe how something operates or is completed. The instructor demonstrates the procedure for the class and walks them through it step-by-step (Daluba, 2013). When students struggle to relate theories to real-world situations or when they are unable to comprehend how to apply ideas, demonstration is frequently required.

2.4.4 The Practical "Hands-On" Approach

The practical "hand- on "approach was developed on the basis of the fact that learning by doing is the most effective way to gain scientific skills (Tordzro, Asamoah, & Nyeseh, 2021). The approach is basically concerned with the significant positive yields that can be realized when teaching and learning is done with a blend of theory and practice, as opposed to the solely theoretical approach. When students are made to actively participate in the learning process, they are able to develop a keener interest in the subject of study, enhance their capacity for laboratory work, and also deepen their insight into what is being taught. As the natural sciences emphasize the principles of empiricism and thus seek to describe, understand, predict and control phenomena, it is crucial that teaching and learning be done practically as well as theoretically. One of the proponents of this paradigm, Freedman (2009), argue that for a student to be motivated in a particular line of study, a practical exposure to what is being studied is as important as an interest in the area of study.

Also, the similarity between laboratory work and real-life situations can be a contributory factor in the learning process. Here, researchers in the field assert that an application of real-world contexts in the study of science particularly helps to efficiently assimilate the various theoretical concepts and ideas concerning the subject (Wandersee et al., 2014). The active participation of students in the learning process made as a result of practical or hands-on study approaches have therefore been noted to facilitate learning, especially with regards to the natural sciences including biology (Torres, 2018). In the teaching and learning of biology the practical mode of instruction adopted as noted by Hill et al., (2016) to afford students the opportunity to apply, explore and come up with guided but insightful understanding of the course, and this also translates into good rate of recall. Another key concern that emphasizes the need for the practical

instruction when it comes to the teaching and learning of biology is the fact that in both internal and external examinations entail practical components and the students will invariably be better placed to excel in these tests when instructions are given practically. As Zogza (2016) put it, biology education is a unique discipline with special teaching and learning contexts. Due to this, he argues that research must be aimed at throwing light on how students can be guided to understand the biological world. For example, in the Unites States, students who seek to pursue courses in biology are guided to attend a few summer workshops or seminars, and then move directly to the classroom, thereby skipping the traditional all theory lesson approach. A similar trend exists in the UK, and here the state guides students to undergo an apprenticeship mode of training (Matthews, 2015).

2.5 Challenges of Teaching and Learning of Biology

Researchers from all across the world have looked into how difficult it is for students to study biology (Cimer, 2012). Secondary school students may find it challenging to understand variety of biological ideas or topics, such as the transportation of water in plants, the synthesis of proteins, respiration and photosynthesis, gaseous exchange, energy, cells, mitosis and meiosis, organs, physiological processes, hormonal regulation, oxygen transport, genetics and the functioning of the central nervous system (Etobro & Fabinu, 2017).

Hormones, genes and chromosomes, mitosis and meiosis, the nervous system, and mendelian genetics were also discovered by (Tekkaya, Özkan, & Sungur, 2001) to be challenging subjects for secondary school pupils. Students' motivation and achievement are significantly impacted when they struggle with so many biology courses (Özcan, 2003). Students struggle to understand biological concept for a variety

of reasons (Tekkaya, Özkan, & Sungur, 2001; Çimer, 2004). Learning science can be challenging for a variety of reasons, including the nature of science and its teaching techniques. Etobro & Fabinu (2017) contend that learning biology is challenging because of the biological level of organization and the abstract nature of the concept. The other reasons hindering students from learning biology properly include overburdened biology curriculum, the abstract and multidisciplinary nature of biological topics, and issues with the textbook (Chiapetta & Fillman, 1998; Tekkaya, Özkan, & Sungur, 2001). According to Chiepetta and Fillman (1998), overcrowded biology courses may not help students attain their goals and instead encourage them to memorise the content.

According to Osborne and Collins (2001), the lack of discussion of issues of interest and the lack of possibilities for creative expression are other factors contributing to students' declining interest in learning science. The curriculum content is also overloaded and often unrelated to working life. Biology instruction styles, methods, and strategies used by teachers may also have an impact on how well students understand the subject (Çimer, 2004). Science teachers encountered the challenges when attempting to teach biology concepts in the classroom, including the lack of teaching aids, a lack of school-provided reference material, a lack of class time, a lack of textbook content, and a high content level relative to students' comprehension levels (Rasmitadila, Aliyyah, Rachmadtullah, Samsudin, Syaodih, Nurtanto, & Tambunan, 2020)

2.6 Review of Related Studies

A study on the issues with biology instruction and learning in senior high schools in Nigeria identified a variety of challenges, including a lack of specimens for biology

practical and inadequate or subpar equipment for biology practical. It was found that improvising the specimen by the instructor, students, and other authorities, as well as assistance from parent and Non- Governmental Organizations in the acquisition of actual materials and equipment, are workable solutions to these issues (Abdussemiu, 2022).

Some researchers have found that a variety of factors, including the peculiar knowledge and skill set of the teacher, which can be below par, factors such as inadequate and inappropriate instructional materials, the medium of instruction, lack of effective supervision and monitoring at school, a lack of teacher motivation, and a shortage of qualified teachers to fill open classrooms, can all have an impact on the quality of science teaching and learning. It is crucial to keep in mind that a teacher's proficiency is not solely dependent on their knowledge of the subject matter, it also depends on how they choose to introduce, organize and structure for the learning process for the study of biology (Hattie, 2012). This job demonstrates the importance of teaching expertise in the determining whether a study program is beneficial or not.

Poor attitude and lack of motivation on the part of students, among other things, have the ability to undermine the study of biology (Quansah, Sakyi-Hagan, Essiam, 2018). These results highlight the difficulties that teachers and students both confront during the learning process.

2.7 Research Paradigm

It is frequently necessary to combine many research approaches in order to enhance conclusions, better contextualize or explain results, or reduce the shortcomings of a particular methodology. Studies in biology are increasingly highlighting the use of mixed method research, which combines quantitative and qualitative data to look at

relevant issues in biology teaching and learning. (E.g., Andrews *et al.*, 2012; Jensen *et al.*, 2012; Host *et al*., 2013; Ebert-Mary *et al*., 2015; Seidel *et al*., 2015). Mixed method research, which involves which involves gathering, analyzing, interpreting and reporting both qualitative and quantitative data, is a methodology that combines multiple methods to address research questions in an appropriate and ethical manner (Bryman, 2012; Creswell, 2015; Creswell & Plano Clark, 2011), There are various research paradigms, some of which are complementary to one other, and some of which are antagonistic. Positivism, which holds that only knowledge validated by the senses is affirmed as knowledge (Bryman, 2012), is one of the most common research paradigms. It emphasizes acquiring objectively verifiable information through the use of quantitative methods, following the objective research approach. Positivists differentiate between scientific and normative claims and hold that only the former are truly within the purview of the scientist (Bryman, 2012). They also hold that normative assertions cannot be verified by the senses.

On the other hand, post-positivism, "is a milder form of positivism that follows the same principles but allows more interaction between the researcher and his/her research participants" (Taylor & Medina, 2011). Post-positivism allows for subjectivity while positivism emphasizes on the objectivity of the research process. As a result, it employs both quantitative (like a survey) and qualitative methods (like participant-observation and interviews) methodologies. A different paradigm, interpretivism, holds that there are various realities and has a different epistemology from positivism. The use of the scientific (or positivist) model in the study is thus criticized by those who subscribe to this paradigm (Bryman, 2012). The subjective significance of social activity is respected by social scientists that follow this paradigm (Taylor & Medina, 2011). Therefore, interpretivists, comprehend social processes and provide them further

interpretation. Contrary to positivism and interpretivism, constructivism is founded on the idea that reality is a result of people interacting with the real world. It is motivated by the conviction that human engagement with the real world promotes the active production of knowledge. of knowledge takes place when there is human interaction with the real world.

This indicates that knowledge developed socially. It rejects the notion that knowledge can be produce via a single process and that knowledge must be viewed from a variety of angles. In conclusion, constructivism/interpretivism and positivism/post-positivism are the two basic paradigms, which are typically thought to be fundamentally at odd with one another. The former pertains to quantitative methods, while the latter directs qualitative research. The quantitative study alone was unable to answer all of the research questions, hence the qualitative research was required. The last paradigm is pragmatism, which regards reality as both singular and multifaceted is not dedicated to any particular philosophical perspective (Creswell, 2007). Instead, it contends that forced choices between positivism and interpretivism should be abandoned.

Pragmatism According to Creswell and Plano Clark (2011), pragmatic thinking "is pluralistic and oriented towards 'what works and practice". In other words, pragmatism employs a variety of techniques but the techniques should always be used in response to research challenges. In other to achieve research goals, it values both objective and subjective knowledge. A mixed-methods methodology mixes both post-positivism and interpretivism interweaving qualitative and quantitative data in such a way that research concerns are meaningfully explained. (Fetters, 2016), offering a number of advantages to tackling complex research issues.

Additionally, it provides a logical foundation, methodological adaptability, and a thorough comprehension of smaller cases (Maxwell, 2016). To put it another way, the use of mixed-methods enables researchers to respond to study questions in a suitable depth and breadth and aid in generalize findings and implications of the studied topic to the entire population (Enosh, Tzafrir, & Stolovy, 2014). For instance, using a quantitative technique enables a researcher to collect the data from a large number of participants, increasing the likelihood the result can be applied to a wider population. The qualitative approach, on the other hand, honors the voices of its participants and offers a better knowledge of the problem under investigation.

In other words, qualitative data add depth to the study while quantitative data gives it breath. Additionally, qualitative and quantitative data can be cross-validated. Through the convergence of data from several sources, triangulation, as a qualitative research strategy, enables the development of a thorough understanding of a study problem or the testing of validity (Carter et al., 2014). Therefore, by integrating two sets of strengths and at the same time making up of the flaws of each approach, a mixed-methods design offers the best opportunity of answering research questions (Johnson & Onwuegbuzie, 2004). In light of this, "mixed-method research designs are becoming increasingly relevant to addressing impact research questions" (Saville, 2012).

CHAPTER THREE

METHODOLOGY

3.0 Overview

The techniques and methods used to gather data for the study are described in this chapter. The research setting, target population, sample size, and sampling procedure are all described below, along with the research design. The sequence of observations, the instrumentation, and the pilot testing follow. Validity and reliability of the instrument are further considerations. This final section of this chapter focuses on the method of data collecting, data analysis, and logistical and ethical and logistical considerations.

3.1 Research Design

In order to give pertinent and reliable information, the descriptive survey design was utilized in this study. It combined ways for collecting both quantitative and qualitative data. Paler-Calmorin (2016) asserts that descriptive method concentrates on the present and the "what is" of the circumstance in order to uncover "new truth". Through questionnaire and interview, data were gathered. However, in order to supplement the information gathered from the questionnaire and interview questions, the researcher also made use of observations. To collect quantitative data from teachers and students, separate questionnaires were created. Through the use of standardized interview methods skillfully designed to capture the necessary information on the obstacles of teaching and learning biology from the perspective of both students and teachers, qualitative data were also gathered from the students and their teachers. Utilizing the SPSS, the researcher carefully considered the frequencies and percentages of responses offered by the respondents to get a valid conclusion.

Data from the conducted interviews were audio recorded, transcribed, and subjected to thematical analysis.

3.2 The Study Area

The study was carried out in the Eastern Region, one of the 16 administrative regions of Ghana. Lake Volta, Ashanti Region, and the Bono East Region form its eastern, western, and northern boundaries, respectively. The Central and Greater Accra regions form its southern boundary. There were 26 districts in total in the region as of 2019 (Figure 2). The second cycle institutions in the area were the study's main emphasis.

Figure 2: Map of the Eastern Region Showing the various Districts

3.3 Population of the Study

A target population, according to Cohen (2004), is a collection of elements or cases that meet certain characteristics and from whom a study is intended to be generalized. All Elective Biology instructors and students from every Senior High Schools in the Eastern Region will make up the study's population. In the Eastern Region, there are

90 Public Senior High Schools overall, of which 27 were chosen. A sample of 16 Senior High Schools from population was taken. The researcher chose these Senior High Schools due to the study participants' willingness to participate, to conduct the study because of a variety of reasons, including familiarity and also because they are reachable from where she lives and works.

A portion of the target population known as the accessible population is also referred to as the study population. Researchers take samples from the population that is easily accessible. This demographic was created by second-year biology students and teachers of elective biology because they would not be as focused on finishing their final exams and because they might have studied a significant portion of the biology syllabus. Only form two elective Biology Elective instructors were seen and interviewed; all other biology teachers in the chosen schools were given the questionnaire to complete.

Senior High schools in Ghana are categorized by the Ghana Education Service (GES) into four categories: Categories A, B, C and D. The researcher randomly chose four schools from each category for this study. The researcher was forced to choose only a few schools from among the region's SHSs due to time and cost limitations.

3.3.1 Sample and Sampling Techniques

"Samples are selected based on the fact that they provide a research project insight into a specific experience" Smith et al. (2009) wrote. The researcher collected information from 476 respondents in all, including 26 teachers and 450 students. Thirty (30) pupils from each of the participating schools were chosen using stratified random sampling techniques. The students taking biology as an elective were gathered in all the chosen schools, and 30 of them were chosen at random to complete the questionnaire. All of the 16 chosen schools' elective biology professors were to be included in the study,

according to the researcher. However, because some of the instructors' tracks were on vacation and certain schools had few biology elective teachers, they were unavailable for the study for a variety of reasons without the researcher's control. As a result, 26 instructors in all from the 16 schools were chosen to complete the questionnaire.

3.3.2 Research Instrument

According to Wilkinson and Birmingham (2003), a research instrument is just a gadget used to gather data that is important to the work at hand. Test, surveys, and interviews are among them. The data for this study project was gathered using a variety of equipment. The questionnaire and an interview technique were the two main tools used to collect the data. An observation checklist and audio-recordings of the interview schedules were added to these two instruments. The questionnaire asked respondents to list their age, gender, and the name of the schools they attended. The purpose of the survey was to get information from students about how they felt about various aspects of the institution. The design of the final questionnaire took into account several important factors, including the teaching methods and strategies used by biology teachers, the adequacy of human and material resources, the equipment and logistics needed to conduct biology lessons, the opinions of students regarding the effectiveness of biology teachers, and the amount of time allocated for theory and practical lessons in biology.

The purpose of the teacher questionnaire is to guarantee that teachers provide both demographic information and some personal information about themselves. They had to supply information about their schools' classification, the number of students enrolled in the elective biology classes, and the students' gender. Additionally, the teachers had to supply information on the tertiary-level courses or specializations they

had taken. Additionally, they submit information on their years teaching experience and their academic background. The purpose of the questionnaire was to collect information from instructors about various internal and external elements that have an impact on how biology practical and theory classes are taught in the classroom, as well as the availability and suitability of lab and practical equipment, from the perspective of the teacher. Last but not least, the questionnaire sought the respondents' opinion teachers on the logistics and purchase of biology equipment.

3.3.3 Validity of the instrument

The degree to which the measure is truly measuring what supposed to be measured is referred to as validity. A questionnaire's face validity, content validity, construct validity, statistical validity, ecological validity, and internal and external validity are just a few of the validity types that can be considered while evaluating it (Leavy, 2017). however, according to Creswell & Creswell (2018), among this form of validity, the three forms that need to be looked for are consult validity, which looks at the item measuring hypothetical consults or concepts, predictive or concurrent validity, which looks at scores predicting a criterion measured and do results correlate with other results, and content validity. Overall, validity enables the researcher to access the suitability of the questionnaire for survey research. The questionnaire items were given the researcher's supervisor and other lecturers in the science education department who were experts in science education for close examination to ensure that it measured the entire content area of study. This was done to ensure the questionnaire and interview items for both teachers and students measured what it was intended to measure. This was done to guarantee the things' legitimacy on both the outside and inside. Changes were made as a result of comments and suggestions made after the supervisor examined the instruments. incorrect items were removed, new ones were added, and existing ones

were modified as a result of the adjustment.

3.3.4 Reliability of the instrument

The constancy of the outcome is referred to as reliability. The two reliability tests that are most frequently used to examine the internal consistency of scales are factor analysis and Cronbach's alpha (Leavy, 2017). These tests assess how consistently sets of items behave (Creswell & Cresswell, 2018). The quantity of items and their average intercorrelation affects Cronbach's alpha. Consequently, a high Cronbach's alpha score might suggest a high level of reliability. However, it may also mean that the responses may influence one another because respondents might try to be consistent by remembering their earlier responses. A low value, on the other hand, can be an indication of low dependability or even the measurement of different constructions (Wiley, 2020). A pilot test of the instrument was conducted with 70 students in one of the schools that has similar characteristics with the chosen schools in order to determine the reliability of the questionnaire. The selected pupils weren't involved in the primary investigation. This was done to prevent contamination of the study sample and, consequently, its findings. Using Cronbach-Alpha, the questionnaire's reliability was assessed.

3.3.5 Data Collection Procedure

In order to formally present herself to administrators and instructors as well as become familiar with the conditions of the various schools, the researcher first set out on a number of familiarization visits to the chosen schools. An introductory letter from the Science Education Department of the University of Education, Winneba was sent to the Heads of Senior High Schools chosen to allow this study to be conducted. Before the study tools were used, teachers and students were given guarantees of confidentiality

and anonymity. The interview sessions came after the surveys. The teaching of the topic during biology lessons (theory and practical) was observed in the classroom. Additionally, the laboratories at the different schools were visited in order to personally assess the condition of the setups, tools, and readiness for actual work. Finally, Heads of Department of the various selected schools completed checklists on the condition of the facilities and equipment for biology practical courses.

To start, the student participants were given a questionnaire that included a measurement of the resources available for the teaching of elective biology as well as a measure that elicited the type of the activities that take place during the teaching and learning process with regards to biology in the senior high schools from the perspectives of the student participants of the study. The lather scale had items such as "The teacher makes use of sufficient resources (pictures, tables, animations, computers, etc.)", "I am allowed to ask questions to aid my understanding of concepts" and "The teacher involves me in practical activities". The former scale has items such as "Is the school well-resourced for the teaching of Biology?", "Do the facilities promote the teaching of biology?", "Does the school have a laboratory for the teaching of biology?" amongst others. Both assessments are given on a Likert scale, with responses ranging from Strongly Disagree to Strongly agree and from Always to Never, respectively.

The second hypothesis related to how biology was taught and learned in the senior high schools that were chosen. It stated that teacher -students centered interaction would predominate over the student-student, and student-resources, and student-resources interactions with pupils. The type of interaction that occurs during the teaching and learning of biology in their classrooms was one of the questions given to the student participants. There were four different interaction techniques available: teacher-

students centered, student-student centered, teacher-resources centered and the student-resources centered.

The final research question had to do with an exploration of the challenges confronting biology teachers and students in biology education in the Senior High Schools.

3.3.6 Data Analysis

The Statistical Package for Social Science was used for all statistical analysis. Descriptive statistics, such as percentages, standard deviations, average, etc., of the participant responses were used to interpret the data for the study questions. By using the six steps of thematic analysis proposed by Braun and Clarke's (2006), the study found recurring themes within the responses. The study's data was iteratively read to become familiar with the material so that the six steps of thematic analysis may be carried out efficiently.

The familiarization process, according to Braun and Clarke, is the first stage of thematic analysis. In order to uncover patterns and meaning, the researcher immersed herself in the data at this point by actively or intently listening to audiotaped interviews or by reading and rereading the data gathered. In order to become familiar with the entire body of the data, the data were read repeatedly.

Following this initial familiarization, preliminary codes were created by underlining words and making notes in order to find trends in the data. The data was then processed in a methodical and meaningful fashion by coding into a few small chunks of significance. The researcher had the option to code either from an inductive or a theoretical perspective standpoint at this step. In the first style of coding, each participant's line was coded separately using a line-by-line method. Theoretical coding

refers to coding that is carried out in accordance with or with reference to study topics. Here, the researcher codes portion of the data that pertains to the study question or is interesting or significant. The researcher in this study coded the information gathered.

Thirdly, all pertinent codes were acquired before the codes were organized into probable topics. A theme is a pattern that incorporates information that is intriguing or significant to the research objectives, according to Braun and Clarke (2006). Thus, a theme is defined by its importance. The key subject that responds to the study question was then determined by analyzing the codes. To assess the patterns' applicability to the study questions, almost all of the themes are descriptive. While the majority of codes are linked to just one theme, certain codes are linked to many themes.

Each code was evaluated, refined and edited to make sure that the patterns were cohesive before moving on to the next stage, which entails review of themes. The numerous themes were also examined to determine their applicability to the codes and the full body of data. Here, all the information related to each theme were compiled in order to assess if they support or contradict the theme. It was then assessed whether the theme holds true in light of the data collection.

The definition and naming of themes make up the next stage of Braun and Clarke's thematic analysis. Mostly people see it as the themes' ultimate polish. Here, each topic was described while connecting each theme to the data acquired to determine the significance of each theme. The following typically queries were posed when defining and identifying the themes: What is the concept trying to convey? How do subthemes related to and connected to the main theme? What connection does each theme have to the others?

Finally, a summary report that compiles all the study's findings in accordance with the research questions was created.

3.3.7 Ethical consideration

Participants were fully educated about the methods and dangers associated with study in order to provide informed permission, which is an ethical requirement in research. By discussing and providing participants with specific information about the study's objectives, informed consent was used in the study. The confidentiality of the participant was ensured by the researcher. The researcher rigorously abode by the principle of anonymity, which essentially states that no participant's identity would be divulged at any point during the study, not even to the researcher. Here, names of participants weren't needed to be disclosed and privacy was guaranteed.

Permission was obtained from the appropriate authorities, including the heads of the senior high schools, department heads, teachers, and students who were an integral part of this study, in order to access the necessary data. When collecting sensitive or public information, a particular focus was placed on the secrecy or anonymity of surveys and interviews. The usage of the voice recordings that were transcribed from the respondents (teachers and students) was also requested. Without sacrificing the study's quality, it was completed within the allocated time and budget.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Overview

The findings of the study were presented in this chapter after the data set from the study had been analyzed. The result of the findings was examined.

4.1 Background Data on the Study Participants

A total of 450 students made up the study's sample. 432 of them, representing a total of 16 schools filled out the questionnaires. 26 Biology teachers also filled out questionnaires and were interviewed.

4.1.1 Distribution of Student Participants by Category of School

Students were chosen at random from all four GES categories of schools. Out of the total number of 432 students, 80 and 120 were from the category A and category B schools representing 18.52% and 27.78% respectively (Figure 3). 132 students forming 30.6% of the entire sample, attended category C' schools, while the remaining 100 respondents, representing 23.15%, attended category D schools. The teaching and learning of Biology in the numerous Senior High Schools in the districts of New Juaben North, New Juaben South, Manya Upper Krobo, Manya Lower Krobo, Akwapim North and Akwapim South Districts of the Eastern Region were fairly represented by this study.

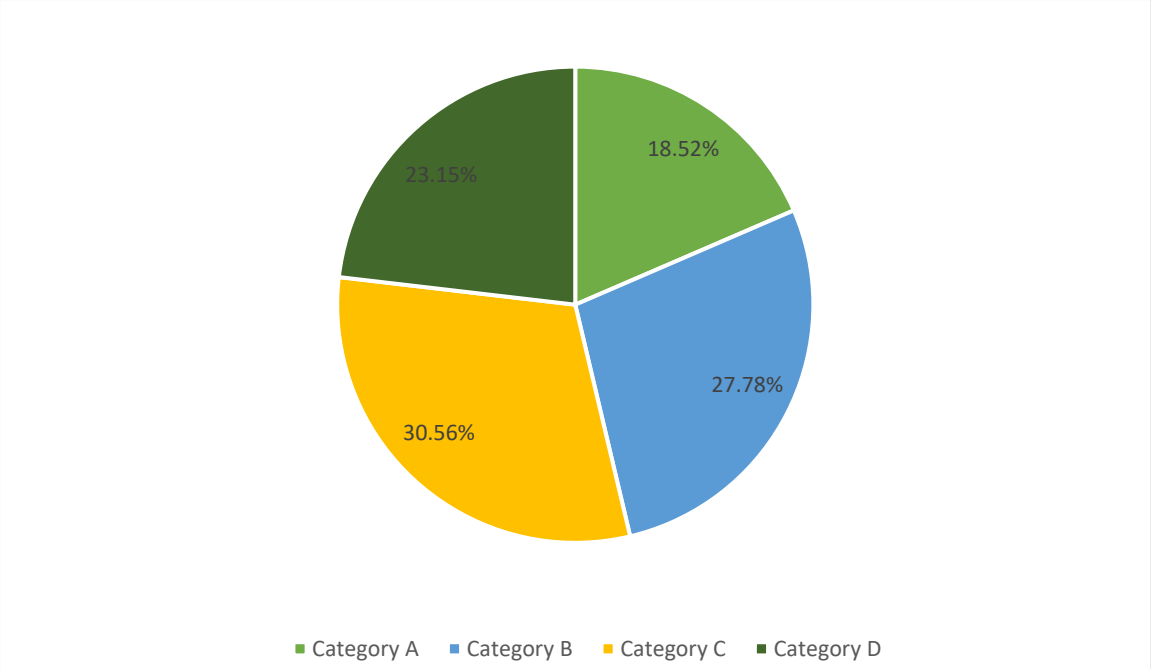

Figure 3: Percentages of Participants According to GES Categorization

4.1.2 Distribution of Student Participants by Sex

The students were sampled from mixed senior high schools. Out of the total of 432, 61% of the participants, that is 264 were female and the remaining 168, representing 39% were males.

4.1.3 Age Distribution of Student Participants

The ages of the students who took part in the study was also noted to be between 15 and 19 years with an average of 17.4 (Figure 4).

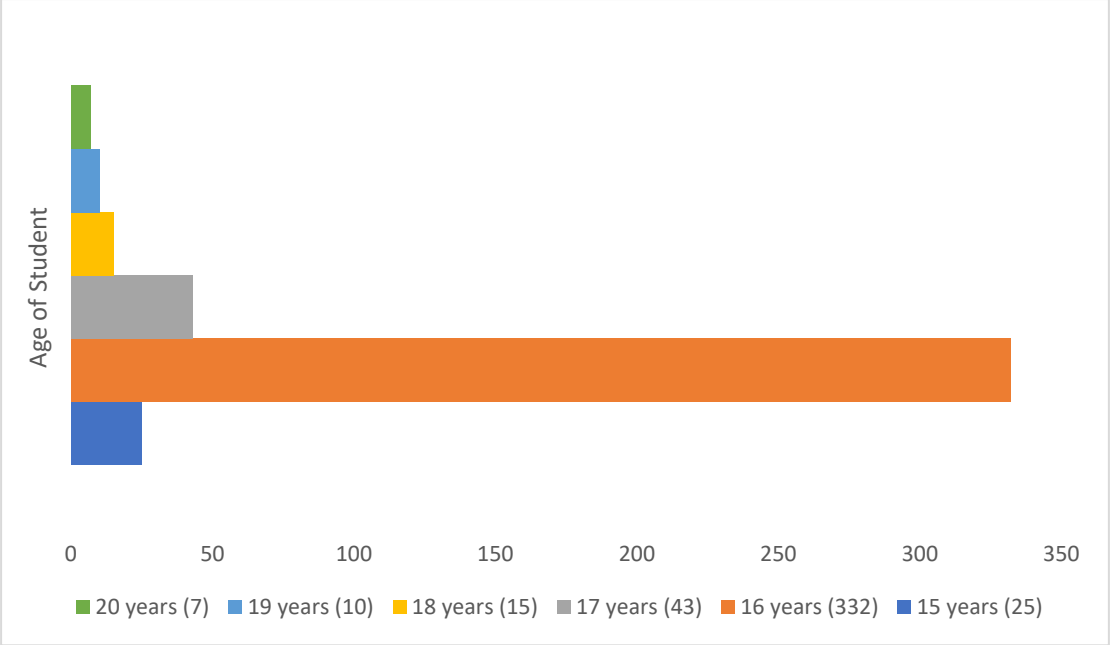

Figure 4: Age Distribution of Student Participants

4.1.4 Distribution of Teacher Participants by GES School Categories

26 teachers were recruited for the purposes of the study. Eight, six, six and six teachers were sampled from schools in categories A, B, C and D respectively. They were also 16 females and 10 males.

4.1.5 Distribution of Teacher Participants by Highest Qualifications

From a perusal of the qualifications of the teacher from the data set, there were 19 of them holding Bachelor's degrees, 6 holding MSc and the remaining 1 holding MPhil degrees.

4.1.6 Distribution of Teacher Participants by Professional Qualifications

The professional qualification of the teacher participants in the study were also gleaned with the use of a 3-option scale comprising 3-year post secondary education, diploma in education and then Master of Education. 23 of them had diploma in education as their professional qualification, and then 1 and 2 of them indicated having 3-year post

secondary education. and Master of Education respectively. With regards to the area of specialization, all the teachers indicated Biology as their area of specialization.

4.1.7 Distribution of Teacher Participants by Gender

Again, with regards to the teachers, the gender distribution of the teachers was 16 to 10 for the males and females respectively.

4.1.8 Distribution of Teacher Participants by Subjects Taught

The review of the responses also suggested that 16 of the teacher participants taught only Biology while 10 of them taught other science subjects in addition to Biology (Figure 5).

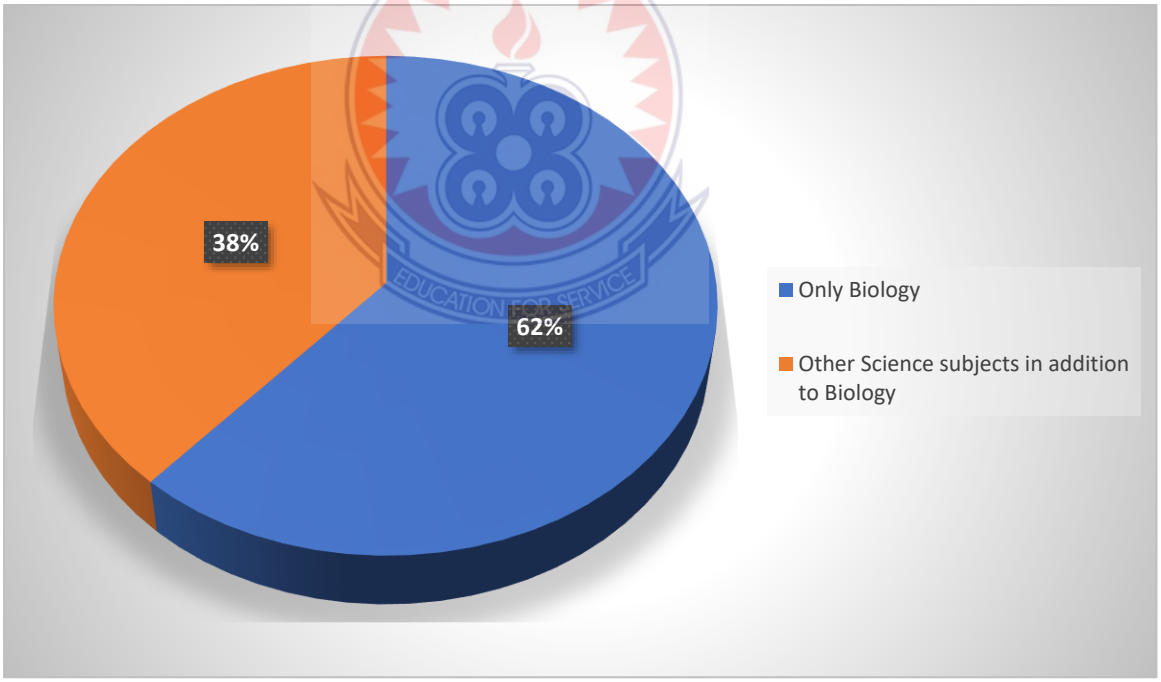

Figure 5: Subjects Taught by Teacher Participants

4.1.9 Distribution of Teacher Participants by Elective Biology Class Size

It was noted that a majority of the teachers reported to teaching more than 60 students, while others said they had as much as 200 and as small as 30. This information relates

to the number of students in the elective Biology classes of the teacher participants (Figure 6).

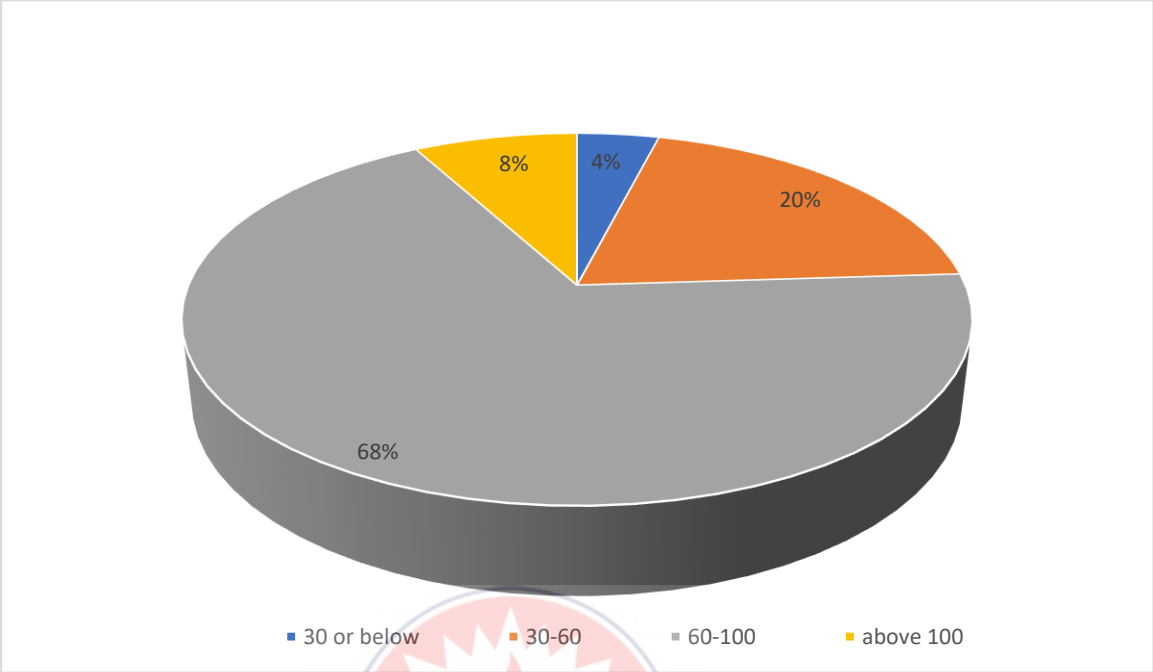

Figure 6: Elective Biology Class Sizes

4.1.10 Distribution of Teacher Participants by Instructional Approach

While just eight of the participating teachers said they used the practical approach in teaching or instructing in biology lessons, 18 of them said they used the theory-based approach (Figure 7).

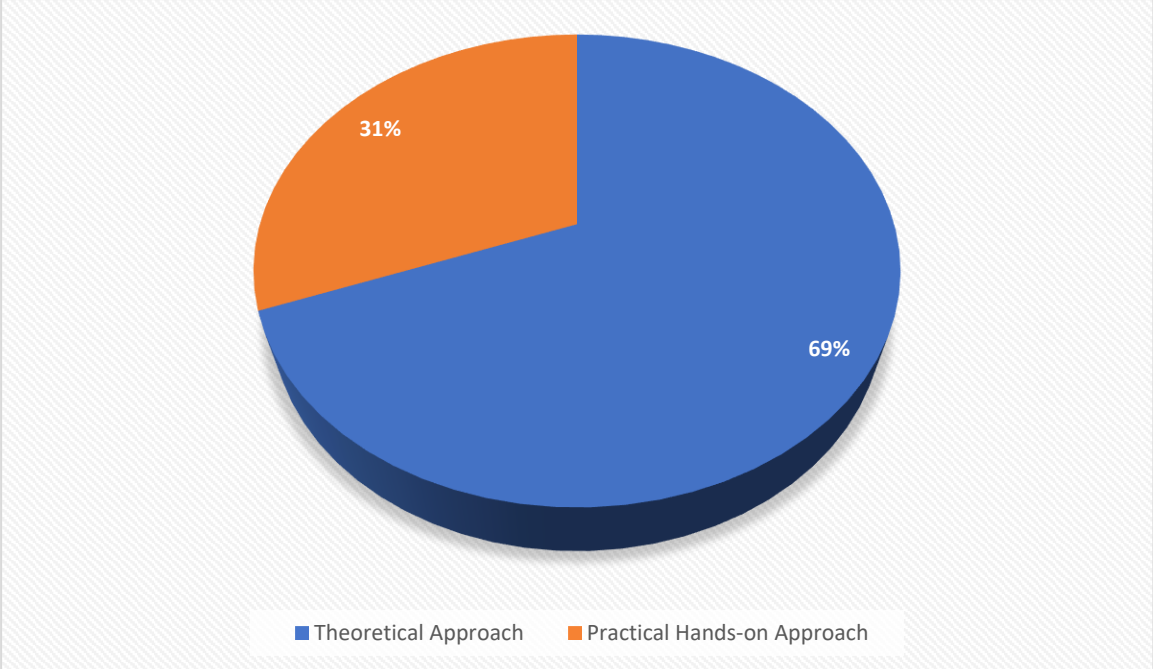

Figure 7: Teachers' Instructional Approach

4.1.11 Distribution of Teacher Participants by Assessment of Biology Principles and Concepts

For the options "At the end of each lesson", "At the end of teaching each topic", "During organized term quizzes", "Before the start of term exams", and "End of term examinations", Figure 8 illustrates the responses as gleaned from the data set.

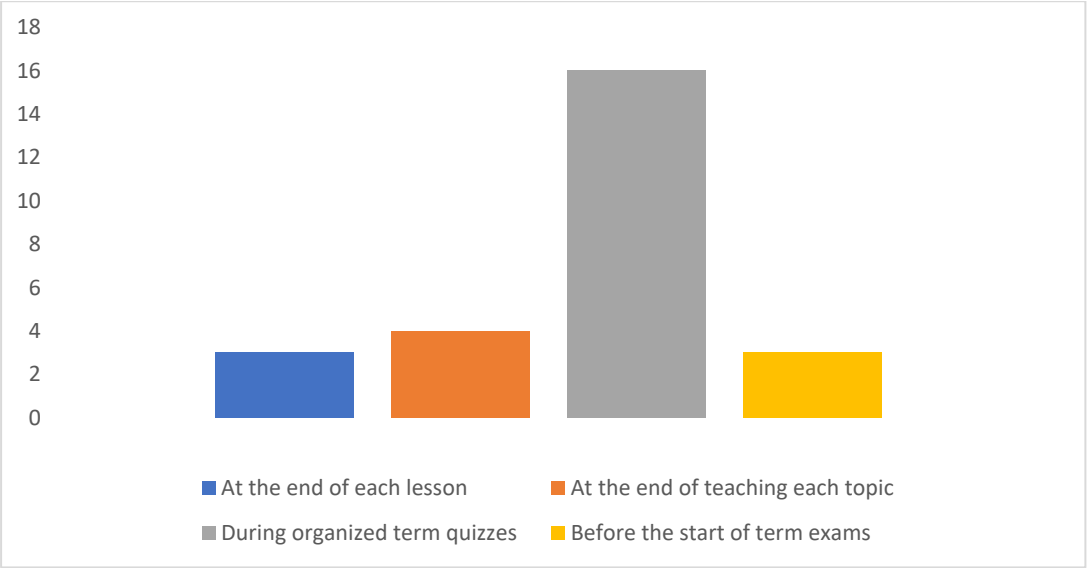

Figure 8: Assessment of Biology Principles and Concepts

4.2 Research Questions

4.2.1 Research question 1: How is the infrastructure for teaching biology in senior high schools in the Eastern Region, Ghana?

Table 1: Summary of correlation analysis showing the relationship between Resources Available for teaching biology and activities during biology lessons

Correlation		Resource Available	Activities during class
Resources Available	Pearson Correlation	1	.56
	Sig.(2-tailed)	-	0.04
	N	432	432
Activities during class	Pearson Correlation.	.56	1
	Sig.(2-tailed)	0.04	-
	N	432	432

From table 1, Pearson correlation coefficient between availability of resources for teaching biology variable and activities during biology lesson variable is 0.56 This suggests that there is a perfect positive correlation between the two variables. It indicates that there is a proportionate increase in the Activities during biology lessons variable for every increase in resource provided. This perfect linear relationship suggests that, with no deviation from the trend, increases in the availability of resources in teaching biology will directly and continuously be linked to an increase in activities that takes place during biology lesson thereby in improving understanding and retention of concepts been taught.

In other words, a decline in activity in class will be positively correlated with a fall in the resources available for teaching biology in the senior high schools.

The value of Sig.(2-tailed) of 0.04, means that there is a real or significant relationship between resources availability for teaching biology and activities during biology lessons.

Resources in this context relates to the numerous buildings and pieces of machinery utilized in senior high schools to teach and learn biology practically. These include things like the laboratory, specimen, and microscopes, among others, that are utilized to provide students the chance to put what they are learning into practice. The teaching and learning process is facilitated by laboratory facilities, ICT gadgets, and educational teaching and learning materials (Anaman, Zottor, & Egyir, 2022).

According to the literature on the topic, selecting the right teaching and learning resources is a crucial aspect of the teaching and learning process. According to Opara and Etukudo (2014), having instructional resources like specimens for biology lessons, gives students the chance to use of their senses, specifically their senses of hearing, smell, sight, taste and physical touch.

4.2.2 Research question 2: How effective are biology lessons taught and how are students taught biology in selected Senior High Schools in the Eastern Region, Ghana?

Table 2: Summary of descriptive analysis showing the frequencies and percentages of type of interaction in biology classroom

Variables	*Frequency*	*Percentage*
Teacher-Students centered	342	79.2
Student-Student centered	48	11.1
Student-Resources centered	42	9.7

From Table 2 above, majority, that is 342 corresponding to 79.2% of the student participants, indicated that the nature of interaction used in the classroom was the teacher-student centered approach. The other student participants representing 11.1% and 9.7% indicated that they experienced student-student and student-resources centered interaction respectively.

These findings are significant as they highlight one key challenge of providing biology education to the students with minimal focus on the practical or hands-on, demonstrative, project teaching and learning strategies. This hypothesis also responds to the second research question, which explores the approaches adopted by biology teachers in the chosen Senior High Schools in the Eastern Region in the teaching and learning of Biology.

From the literature review, the project-based learning connotes a student-centered teaching strategy that enable students to actively explore issues and problems from the real world in order to gain a deeper understanding of what is being taught. through active exploration of real-world challenges and problems (Udo, Nsit, Onyebuchi, & North, 2021).

4.2.3 Research question 3: What difficulties do biology instructors and students have in teaching biology in the senior high schools?

Table 3: Emergent themes/challenges with corresponding codes

CHALLENGES/THEMES	EXAMPLES/CODES
Inadequate Equipment and Laboratory Facilities	Not many equipment for practical
	Lack of well-equipped laboratory
	No proper laboratory
	Lack of tools and facilities
	Insufficient resources for practical
	Poor lab infrastructure

Theoretical Teaching and Insufficient Practical Application	Teaching is mainly theoretical and not practical More time must be allocated to practical work Difficulty in answering practical questions Teachers should allow us to use the equipment in the lab Inadequate teaching materials Inadequate textbooks for more knowledge Low rate of practicals Teachers don't write notes but only give group works Lessons are not detailed, and the teacher does not give notes Not enough resources for practicals
Engagement and Interest	Lessons are not interesting Feeling sleepy during lessons
Teacher-related Issues	Teachers rarely come to class Teachers not always being in class
Inadequate Learning Materials	Inadequate books Insufficient textbooks Available materials are old Lack of biology specimens

Majority of the participants, that is 392, representing 90.7%, indicated that they experienced some challenges with regards to the teaching and learning of the subject, while 40 of them, representing 9.3%, indicated that they experienced no challenges. The aforementioned answers, the research question about whether the participants encountered any difficulties with the teaching and learning of biology in the selected senior high schools. Some challenges that were identified as themes derived from a number of codes from the data set through the examination of the questionnaire given to the participants and the interviews are Inadequate Equipment and Laboratory

Facilities, Theoretical Teaching and Insufficient Practical Application, Engagement and Interest Challenges, Teacher-related Issues and Inadequate Learning Materials.

The final hypothesis also stated that the student participants would report having challenges with regards to the learning of biology. This hypothesis was confirmed from the analysis of the data set from table 3 above.

In addition to the above, the researcher obtained from the teachers and student participants' ways by which the identified challenges to the teaching and learning of biology can be resolved.

Table 4: Emergent themes for solutions with their corresponding codes

SOLUTION	EXAMPLE
Provision of Adequate Equipment and Resources	Getting enough equipment for practicals
	Adequate teaching materials
	Provision of adequate resources
	Provision of well-furnished facilities and equipment
	Adequate practical resources should be provided
	Provision of resource equipment
	Provision of enough textbooks
	Government must provide adequate materials and equipment for practicals
	Provide tools for practicals
	Provide equipment
	Supply new materials for practicals
	Enough equipment should be provided
	Supply some biology specimens
	Supply new materials for practicals
Practical Implementation and Teaching Methods	There must be practicals on topics learned
	Teachers must use pictures and animation to teach
	Teachers must bring practicals to make the class interesting
	Conduct more practicals

Teacher-related Issues	Educating the teacher Provision of adequate practical apparatus Teachers should be motivated and supervised Teachers must come to class daily

From table 4, the following suggestions were made by teachers and students' participant as to how the challenges identified in the teaching and learning of biology in the selected Senior High Schools can be resolved:

- Provision of Adequate Equipment and Resources
- Practical Implementation and Teaching Methods
- Teacher-related Issues

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

This chapter discusses the results of the study in light of its objectives and questions, considers their implications, offers suggestions for additional research on the topic, and sheds light on the significance of the study in the improving biology instruction and learning at the senior high school level in Ghana.

In several chosen senior high schools in the Eastern Region, the researcher set out to investigate the difficulties associated with biology instruction and learning. In particular, the researcher wanted to learn about the state of biology teaching in the classroom from the view point of the teachers and students. The researcher also learned about the strategies used for the tuition procedure as well as its difficulties. Data from students and teachers in the chosen schools were gathered as part of this investigation. The current state of biology teaching and learning, its difficulties, and potential future directions were the main topics of discussion. Due to the mixed methodology used for the study, the researcher additionally used hypotheses as a guide for analyzing the replies with the SPSS program.

5.1 Summary

The results from the study identified a number challenges with regards to the state of biology education in the senior high schools. These challenges had to do with the availability of resources, that is the equipment needed for the tuition of the course. They also had to do with the approach that is adopted by the teachers for the teaching of biology in the senior high schools. Finally, the various specific challenges that were gleaned from the study were discussed in detail. These include the lack of equipment

and laboratory facilities, theoretical teaching and lack of practical application, engagement and interest as well as teacher-related issues.

5.2 Availability of resources for Biology education

This was gleaned through the responses that indicated that there were challenges with the availability of resources as well as the approach to the teaching of the course. The first finding was the fact that there was a significant positive relationship between resources available for teaching biology and activities during biology lessons with Pearson correlation coefficient of 0.56. The first hypothesis for the study was that Resources available in teaching biology would positively influence activities that occurs in biology class.

The challenges of learning biology as reported by the student participants in the study is thus a confirmation of the need to enhance the facilities needed for biology education in the senior high schools in the region. Tavares (2015) found that poor classrooms, libraries, and labs affect student performance the most. The classrooms, labs and educational tools available for biology education determines how well students are taught. Biology students cannot take practical classes without scientific laboratories (Olufunke, 2012). The participants also reported large class sizes in some schools and there is a need for this to be addressed. Allotey (2014) also explored the nature of infrastructure in senior high schools in Ghana and indicated that some of the infrastructure for biology education such as classrooms and laboratories were in decay as a result of a poor maintenance culture. These need to be tackled to enhance the nature and quality of biology education.

5.3 Theoretical Approach to teaching biology

Another key finding of the study was the fact that the majority of participants reported to having the experience of being taught with the theoretical approach as opposed to a blend of the theoretical and the practical hands-on approach. While it was gleaned from the responses that 69% of the teacher respondents used the theoretical instructional approach for the tuition of their biology classes, as opposed to the rest who indicated that they adopt the practical approach of teaching. Similarly, from the responses of the student participants with regards to the nature of biology tuition, 318 students indicated that the study was of the teacher-student nature, as opposed to the other modes of tuition. These findings are significant as they highlight some key challenges of providing biology education to the students with minimal focus on the practical or hands-on, demonstrative, project teaching and learning strategies. From the literature review, the project-based learning connotes a student-centered teaching strategy that enable students to actively explore issues and problems from the real world in order to gain a deeper understanding of what is being taught. through active exploration of real-world challenges and problems (Udo, Nsit, Onyebuchi, & North, 2021).

Teachers typically act as facilitators, offering support, direction, and tactical teaching as the process develops. In a project-based learning environment, students work together to solve "purposeful" challenges emphasizing democracy (Johnson, 2002). This regards, students are viewed as active agents who solve real-world problems, engage in realistic work, and develop knowledge and skills while interacting dynamically with their physical and social environments. This allows them to give themselves and the world around them meaning. Contrarily, the demonstrative approach teaches pupils step-by-step procedure (Amaewhule & Chukwudi, 2020). This approach is also very helpful in aiding students come to terms with and position them

to replicate what has been done in class (Daluba, 2013). Demonstration often occurs when students have a hard time connecting theories to actual practice or when students are unable to understand the application of theories.

Finally, it is important to note that the hands-on approach is essential in dealing with some of the challenges presented as it is noted to be the most effective way of gaining scientific skills (Tordzro, Asamoah, & Nyeseh, 2021). According to Freedman (2009), for a student to be motivated in a particular field of study, the practical exposure to what is being studied facilitates the process. This helps them to efficiently assimilate the various theoretical concepts and ideas concerning the subject (Wandersee, Mintzes, & Novak, 2014; Hill, Fombelle, & Sirianni, 2016). A look at the findings of the study revealed that most of the students from the various categories consider the mode of tuition and as such the course as abstract due to the predominantly theoretical mode of instruction. This results in the view of biology as difficult as the students have the burden of thinking out the various concepts and ideas as well as solutions to problems. As a result, the initial interest in most students to take up the science program and subsequently take up biology, dwindles and many of them find biology boring. Some responses from the student participants suggested that the lessons were boring.

According to Delpech (2002), the reliance on passing on of knowledge of biology using the theoretical approach alone in the absence of practical, hands-on activities has the tendency of making science lessons boring. Students are affected by the method of instruction and the amount of interest in their program of choice. They need to have the opportunity to connect what they have learnt in theory to practical everyday life experiences in order for learning to be effective.

From the results of the study, some other challenges with regards to the teaching and

learning of biology in the senior high schools included issues with engagement and interest as well as teacher related issues. In terms of engagement and interest, the responses from the data saw students indicating that lessons were not found to be interesting among others. From the above understanding of the various types of instruction methods, the challenge of interest and engagement can be handled. It is important to draw on the various methods, that is the theoretical, demonstrative, practical or hands-on, and student projects as discussed above in order to create an enabling and engaging study environment for students. Due to this, the orientation of the teachers is critical as these shapes the general learning experiences of the students with regards to biology. It is important also to add that the results showed that the assessment of students' understanding of what has been taught was reported to be done mostly in organized examinations at the end of the term. This can be seen to pose a challenge as teachers are therefore unable to assess the understanding of the students on a topic-by-topic basis in order to clarify topics that were not well understood. This finding is essential as it can go a long way to shape the mode of teaching and assessment of students in biology and other subjects in order to achieve the most results. Other teacher constraints such as large class sizes were also gleaned from the data set.

5.4 Conclusion

The study explored the various challenges of biology education in selected senior high schools in the Eastern Region, Ghana. Results from the information gleaned from the responses of student and teacher participants revealed some challenges regarding the lack of or insufficient laboratory facilities and equipment to facilitate the learning of the program. A predominant reliance on the theoretical approach to instruction, challenges of engagement and interest of students in what is being taught, teacher related issues among others. The unavailability of and inadequacy of resources for the

study of biology was understood in terms of inadequate equipment for practical, unavailability of specimen needed for students' experience of what is being taught, the lack of well-equipped laboratory in some schools, among others. These issues were discussed in detail above. With regards to the challenge of the method of instruction, the discussion above brought to bear the need to have a blend of the various methods of instruction in order to get the highest results in terms of student understanding and ability to replicate what has been taught. It is important also to add that the assessment of lessons when done more frequently enables both teachers and students to have an idea of the progress of lessons. From the above as well as the other findings presented by the study, efforts can be made to provide needed resources, adopt the use of various methods of instruction, among others that will tackle the various challenges and ensure that students have the most of the biology program in order to assimilate it and make effective use of the knowledge acquired while serving as a scaffold for higher learning in the various biology related programs at the tertiary level.

Based on the findings, the study concludes that lack of training and policy governing the use of practical work coupled with inadequate resources and facilities hindered the use of practical work in the teaching and learning biology in secondary schools. The incentives in the present study are to reconsider and reanalyze the benefit of inserting practical work in science teaching and learning endeavors. It has been observed that practical work in teaching and learning generates new knowledge and form the perfect meaning of theoretical science concepts. Although, the use of practical work is limited by many barriers comprising the lack of science resources and infrastructures if it's the perfect implementation in science academic actions is highly significant for learners and teachers. Practical work is an indispensable element of biology teaching and learning that is aimed at improving learners' knowledge. Learners are willing to be

engaged in building their own knowledge through practices. The education method that intrinsically motivates learners and brings their interest toward learning, develop learners' critical thinking and develop their own learning is nowadays adopted in different corners of the world. Learning by doing can help learners to create and to solve the problem encountered by society and the world.

5.5 Implications

The significance of the research work is the fact that it has gleaned some challenges in biology education in the senior high schools within the selected schools in the Eastern Region of Ghana. The purpose of this study and the application of its findings is to highlight the difficulties and investigate solutions for better subject teaching and learning. Giving students the chance to apply what has been learned to actual, everyday problems is crucial for problem solving. The study thus provides vital information to the government, Ministry of Education, the Education Service, school administration, teachers, students as well as other stakeholders with regards to the challenges that are present in order to bring about the necessary input from the discussions above that will enhance the current state of biology education.

Also, the insights gleaned from the study as well as similar studies will influence teacher training programs particularly with regards to the nature of the focus and method of instruction given in the classroom. It will go a long way to enrich the quality of teacher training specifically with regards to science and biology as teachers are trained to become better at addressing the identified challenges.

Finally, the study and its conclusions contribute to the body of knowledge accumulated in the field of education in general and science education specifically with regards to concerns of the nature in which the subject is taught in order to yield the best results.

5.6 Suggestions

From this study, it is suggested that the government, Senior High School owners, and other stakeholders prioritize the provision of adequate and well-equipped laboratory facilities, equipment, biology specimens and textbooks for the effective teaching and learning of Biology practicals in the schools.

Biology teachers must be motivated to be punctual, engage students and make lessons interesting.

It is suggested that the biology curriculum for Senior High Schools be evaluated to ensure alignment with both international standards for teaching and relevance to students' needs and interests. Also, professional development programs for Biology teachers should be designed and implemented periodically to enhance their pedagogical skills and content knowledge. These would improve the teaching and learning of Biology in Senior High Schools in the Eastern Region and in Ghana as a whole.

5.7 Recommendations

For further studies, it is recommended that more in-depth interviews are conducted with Biology teachers, students and school administrators to gain insight into specific challenges faced and potential solutions. Also, observational studies could be done in selected Senior High Schools to assess teaching methods, use of resources, and student engagement. Comparing Biology education in the Eastern Regional Senior High Schools with other regions or countries can also help to identify common challenges and effective strategies.

Recommendations to educational leaders.

- In-service teacher training prioritizing the use of practical work in teaching and learning should be initiated and sustained.
- Government Funds for education should be allocated to build, equip, and sustain laboratories in schools.
- Develop and implement wide-ranging practical biology frameworks and an essential detailed action plan and their related facilities such as practical teaching manual and teacher's guides.
- Practical biology should be allocated on the school timetable and regular supervision should be carried out in the classroom to ensure effective implementation of practical work.

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APPENDICES

APPENDIX A

CHALLENGES OF TEACHING AND LEARNING BIOLOGY IN SOME SELECTED SENIOR HIGH SCHOOLS IN THE EASTERN REGION, GHANA

QUESTIONNAIRE FOR STUDENTS

Students‟ Questionnaire

Dear respondent,

It is with great pleasure that I am interacting with you through this questionnaire. This research is being conducted as a requirement in partial fulfilment of my MPhil. study in Science Education at the University of Education, Winneba, Ghana. This questionnaire seeks information on the topic: ***Challenges of Teaching and Learning Biology in Some Selected Senior High Schools in the Eastern Region, Ghana.*** The devised questions are for research purposes only and the responses will be treated with utmost confidentiality. You will not be penalized for any answer you give. There is no right or wrong answer to each question. Any information given is solely for academic purposes. You are highly assured of confidentiality and anonymity.

Thank you very much for your time and participation.

SECTION A: Background Information

Please tick in the box the answer you have chosen. Fill in the blank space where necessary

a) Coded name of the school…….

b) Sex: Male [ ] Female [ ] c) Age: ……years

SECTION B:

Resources Available for Teaching Elective Biology

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

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

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

SECTION C:

How often do the following activities occur during your biology lessons? During my biology lessons Always Most of the time Sometimes Rarely Never

SN	DURING MY BIOLOGY LESSONS	ALWAYS	MOST OF THE TIME	SOME TIMES	RARELY	NEVER
8	The teacher makes use of sufficient resources (pictures, tables, animations, computers, etc.)					
9	I am allowed to ask questions to aid my understanding of concepts.					
10	The teacher involves me in practical activities					
11	I work in groups with other classmates					
12	I hold discussions with others on the					

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

	projects, etc.) to assess my work					
18	The teacher marks my quizzes and class exercises on time and gives me a feedback accordingly.					

SECTION D:

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

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

III) Teacher – Resources Centered IV) Student – Resources Centered

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

YES [ ] NO [ ]

B) If yes, mention two of the challenges

i) .....

ii)……

21. Suggest ways by which you think the challenges you have identified in item 20 B) above can be minimized or controlled

.....

.....

APPENDIX B

CHALLENGES OF TEACHING AND LEARNING BIOLOGY IN SOME SELECTED SENIOR HIGH SCHOOLS IN THE EASTERN REGION, GHANA

QUESTIONNAIRE FOR TEACHERS

Teachers‟ Questionnaire

Dear respondent,

It is with great pleasure that I am interacting with you through this questionnaire. This research is being conducted as a requirement in partial fulfilment of my MPhil. study in Science Education at the University of Education, Winneba, Ghana. This questionnaire seeks information on the topic: ***Challenges of Teaching and Learning Biology in Some Selected Senior High Schools in the Eastern Region, Ghana.*** The devised questions are for research purposes only and the responses will be treated with utmost confidentiality. You will not be penalized for any answer you give. There is no right or wrong answer to each question. Any information given is solely for academic purposes. You are highly assured of confidentiality and anonymity.

Thank you very much for your time and participation.

SECTION A:

Please tick in the box the answer you have chosen. Fill in the blank space where necessary

a) Coded Name of School: .....

b) Grade of school: Category A [ ] Category B [ ] Category C [ ] Category D [ ]

c) Coded Name of Teacher: ..... d) Sex M [ ] F [ ]

e) What is your highest academic qualification? HND [ ] BSc [ ] MSc [ ]

MPhil [ ] PhD [ ]

f) What is your professional qualification? 3-Year Post Sec [ ] Dip Ed. [ ] Med [ ]

g) Area of Specialization [Biology] [Chemistry] [Physics] [Biochemistry]

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

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

j) The average number of students in your elective biology class is……

SECTION B:

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

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

SN	ITEM DESCRIPTION	SD	D	NS	A	SA
1	There are some challenges in the cause of teaching biology.					
2	Does your school have adequate equipment, facilities, laboratories and general resources necessary for WAEC designed SHS Biology practical work?					
3	There is enough support for teachers from both within the school and outside, e.g. opportunities for in-service training and workshops, incentives					
4	There is enough time available for preparing and delivering the requirements of the biology course, e.g. enough time to develop your own understanding of the subject you are required to teach					

5	Have you ready access to science materials and resources in this school to enable you teach the biology programme as demanded by the objectives of the curriculum and WAEC?					
6	Is the time allocated for biology practical work sufficient? Does Biology suffer because of this?					
7	During lesson delivery do you introduce activities that promote mutual learning among students as well as encourage students to initiate collaborative inquiry-based learning?					
8	Does the biology programme enable students to acquire the relevant manipulative skills that enable them to handle and operate science equipment and materials effectively at the end of the lessons?					

SECTION C:

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

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

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

E) End of term examinations.

10)i What instructional approach do you adopt in teaching your biology lessons?

(a) Theory approach (b) Practical hand-on approach

ii. What influence your choice of instructional approach?.....

SECTION D:

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

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

i. .....

.....

ii. .....

.....

APPENDIX C

INTERVIEW SCHEDULE FOR STUDENTS

The purpose of this interview is to access the challenges of teaching and learning biology at this School. Kindly answer the following questions. Your responses will be treated very confidentially.

Thank you for your cooperation.

Interview Items

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

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

   b) If yes, mention two of the challenges.

i. .....

ii.....

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

   .....

   .....
9. By which approach are you often taught biology, theoretical, practical or both?

APPENDIX D

INTERVIEW SCHEDULE FOR BIOLOGY TEACHERS

The purpose of this interview is to help assess the challenges of teaching and learning biology in this school. Kindly answer the following questions. Your responses will be treated confidentially.

Thank you for your cooperation.

1. Is the school well equipped with both human and material resources for the teaching of biology?
2. a) Does the school have a biology laboratory?

   b) If yes, is the laboratory equipped with adequate specimen, equipment and other materials for effective organization of practical lessons in biology?
3. Are there regular supplies of laboratory materials and equipment in the school from MOE/GES?
4. Do you allow your students to interact with teaching and learning materials during biology lessons?
5. How often do you organize practical lessons in biology in a week?
6. a) Are there any challenges encountered during biology lessons?

   b) What can be done to address these challenges?
7. Do you organize visits to established and commercial farms, scientific and manufacturing organizations forest and game reserves, man-made lakes, seashore and hospitals?
8. What methods of instruction do you use to teach biology concepts and principles to your students?
9. How do you incorporate technology during biology lessons?

APPENDIX E

OBSERVATION CHECKLIST ON THE STATE OF INFRASTRUCTURE AND RESOURCES

Coded name of school:

Date of observation:

Time:

Legends:

5-Exceeds expectations in all respects **4- Meets expectations in all respects**

3-Meets expectations in most respects **2-Meets expectations in some respects**

1-Meets expectations in few or no respects

NO*- Not Observable

Circle/ tick your response to each of the following and then add remarks below the table.

Availability and condition of resources and facilities	5	4	3	2	1	NO*
1. Biology laboratory						
2. Biology specimens						
3. Adequate number of qualified biology teachers						
4. Adequate number of trained and qualified laboratory technicians						
5. Periodic fieldwork						
6. Sufficiency of laboratory facilities						
7. State of repair of laboratory facilities						
8. Supply of chemical/reagent						
9. State of repair of laboratory equipment						
10. Availability of equipment for experiment						

Remarks:

Observed by: _____

APPENDIX F

INTRODUCTORY LETTER

UNIVERSITY OF EDUCATION, WINNEBA
FACULTY OF SCIENCE EDUCATION
DEPARTMENT OF INTERGRATED SCIENCE EDUCATION
P. O. Box 25, Winneba, Ghana
ise@uew.edu.gh
+233 (020) 2041077

Our ref. No.: ISED/PG.2/Vol.1/52
Your ref. No.:

23rd January 2023

TO WHOM IT MAY CONCERN

Ms. Sophia Angmorkwor Korli is an MPhil student in the Department of Integrated Science Education of the University of Education, Winneba. She is currently researching into the topic:

"***CHALLENGES OF TEACHING AND LEARNING OF BIOLOGY IN SELECTED SENIOR HIGH SCHOOLS IN THE EASTERN REGION OF GHANA***".

In the hope of contributing to knowledge on the subject, she would like to administer questionnaires to some of your staff and students. Our students are enjoined to treat all information obtained for research purposes with confidentiality, and same is expected in this case.

We would be very glad if you could accord her the necessary courtesies for conducting a credible study in the interest of our educational system in the country.

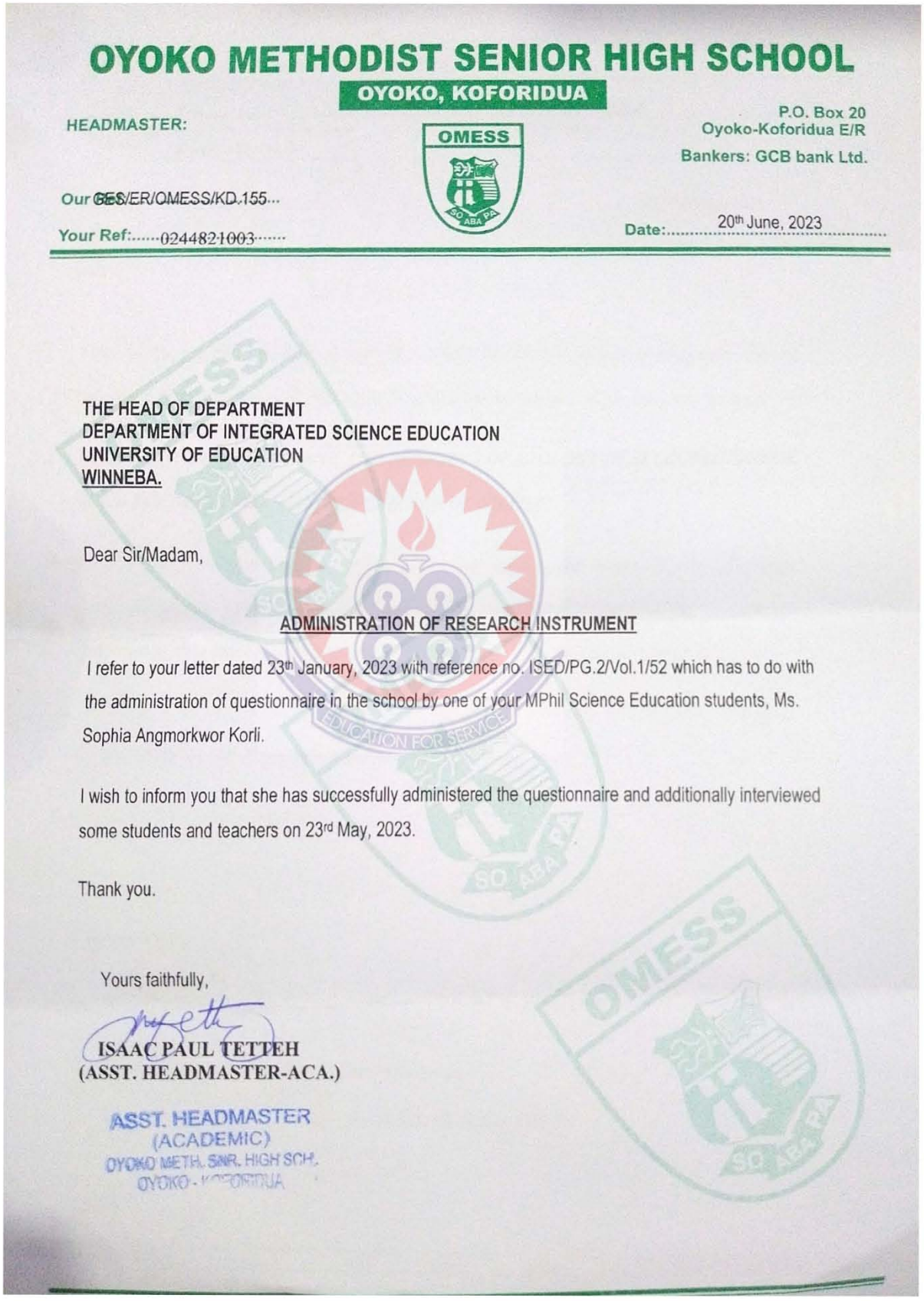
Counting on your usual cooperation.

Yours faithfully,

Dr. Charles Kwesi Koomson
Head, Department of Integrated Science Education
University of Education, Winneba
Email: charleskoomson@yahoo.co.uk , ckkoomson@uew.edu.gh
Contact: 00233244729714

APPENDIX G

LETTER OF RESEARCH ADMINISTRATION



OYOKO METHODIST SENIOR HIGH SCHOOL

OYOKO, KOFORIDUA

HEADMASTER:

OMESS

P.O. Box 20
Oyoko-Koforidua E/R
Bankers: GCB bank Ltd.

Our Ref: GES/ER/OMESS/KD.155...

Your Ref:.....0244821003.....

Date:.....20th June, 2023.....

THE HEAD OF DEPARTMENT
DEPARTMENT OF INTEGRATED SCIENCE EDUCATION
UNIVERSITY OF EDUCATION
WINNEBA.

Dear Sir/Madam,

ADMINISTRATION OF RESEARCH INSTRUMENT

I refer to your letter dated 23th January, 2023 with reference no. ISED/PG.2/Vol.1/52 which has to do with the administration of questionnaire in the school by one of your MPhil Science Education students, Ms. Sophia Angmorkwor Korli.

I wish to inform you that she has successfully administered the questionnaire and additionally interviewed some students and teachers on 23rd May, 2023.

Thank you.

Yours faithfully,

ISAAC PAUL TETTEH
(ASST. HEADMASTER-ACA.)

ASST. HEADMASTER
(ACADEMIC)
OYOKO METH. SNR. HIGH SCH.
OYOKO - KOFORIDUA