

**AKENTEN APPIAH MENKA UNIVERSITY OF SKILLS TRAINING AND
ENTREPRENEURIAL DEVELOPMENT**

MPHIL THESIS

**ASSESSING THE PROFICIENCY OF SENIOR HIGH SCHOOL BIOLOGY
STUDENTS IN BIOLOGICAL DRAWING BASED ON SEX AND SCHOOL
TYPE IN SEKYERE SOUTH DISTRICT**

ERIC YEBOAH

AUGUST, 2024

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BY

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A Thesis Submitted to the Department of Biological Sciences Education of the Faculty of Science Education, Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development in partial fulfillment of the requirements for the award of a Master of Philosophy degree in Biology Education.

AUGUST, 2024

DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original work, and that no part of it has been presented for another degree in this university or elsewhere.

Eric Yeboah

Signature..... Date.....

Supervisor's Declaration

I hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of the thesis laid down by the Akenten Appiah Menka University of Skills Training and Entrepreneurial Development.

Dr. Charles Amoah Agyei

Signature...  Date.....

ABSTRACT

Evidences from Chief Examiners Report showed that students are performing poorly in WASSCE Biology Examinations over the years. Among the reasons adduced was students' poor knowledge in biological drawings. This study therefore investigated the proficiency in biological drawing exhibited by Senior High School students based on students' gender and school type in Sekyere South District of Ghana. Mixed method was the research approach adopted for the study, and thus, quantitative and qualitative tools were used in analyzing data generated from the respondents. The sample for the study comprised of one hundred and fifty (150) students drawn from the population of all SHS2 students offering Biology in Sekyere South Senior High Schools. Five public schools were selected using purposive sampling technique from which the one hundred and fifty (150) students were drawn. The instruments for data collection in this study was Biological Drawing Achievement Test (BDAT) and Interview Schedule (IS) for students and teachers. Prominent among the findings were that majority of the students performed poorly on the rubrics of biological drawing; there were no significant difference in the knowledge of biological drawings possessed by students based on gender; and no significant difference existed in the knowledge of biological drawings possessed by students based on their school type. The study concluded that Senior High School students were unable to present biological drawings correctly due to inadequate knowledge possessed on biological drawings as a result of inadequate practical exposure. Based on the findings, it was recommended that Biology teachers at SHSs should organize practical lessons frequently for students to acquire and master the basic skills in biological drawings, to prepare them towards the ideas and objectives of Biology.

ACKNOWLEDGEMENTS

My sincere to gratitude goes to Almighty God for seeing me through this academic pursuit. It is only by His mercies that I am alive to undertake this work up till its completion. I wish to render my sincere appreciation to Dr. Charles Amoah Agyei, my supervisor for his method of supervision which helped me understood research in its totality, and made me really learn the art of research, statistics and reporting. Also, his encouragements and support were genuine. I am really very grateful Dr.

I am also indebted to all the lecturers in the Department of Biological Science Education, Akenten Appiah Menka University of Skills Training and Entrepreneurial Development for their support and advice, which had enabled me to complete this study successfully.

I am equally grateful to the headmasters/headmistress, Biology teachers and students of the sampled schools for their co-operation during the research period. My special thanks go to Juliana Serwaah Appiah for her encouragement and support in the progression of this study, which had made this work to see the light of the day.

To my Parents, Mr. and Mrs. Yeboah, your love, understanding, prayers, money and affection has kept me thus far. God bless you abundantly. Finally, I express my profound gratitude to all those who assisted me in diverse ways, especially, Mr. Asempa Lawrence Righteous and Mr. Sarfo Kantanka Seth for their invaluable contributions towards the success of this research.

DEDICATION

This thesis is dedicated to God, my Family and Friends.

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CHAPTER ONE

INTRODUCTION

1.1 Overview

This chapter consist of background to the study, statement of the problem, purpose of the study, research question, significance of the study, delimitation, limitation, definition of terms as well as the organization of the study.

1.2 Background to the Study

Science and technology are inevitable tools in the current drive towards a guarantee of good life, peace, security and survival of humankind. Science curricula are mainly aimed at helping students to acquire related knowledge and skills (Demir, Sipahi, Kahraman, & Yalcin, 2007) and to produce scientifically and technologically literate individuals (Tasdemir & Demirbas, 2010).

Any country's progress depends heavily on science education. The rate of economic development of countries has been impacted by developments in science and technology, which have also improved living conditions globally and addressed some of society's most pressing needs and challenges. Science and technology have an effect on these areas as well as on health, nutrition, transportation, and communication. Our ability to use scientific and technological knowledge to address real-world human problems is essential to our ability to survive. In light of this, Ghana has made science an essential part of the academic program in order to generate individuals who are scientifically literate and capable of making thoughtful decisions in both their personal and professional life.

The study of life, requires careful observation and description. One excellent way to describe an object is to draw it. The goal of the observer is to move beyond simple, mental images of what he/she believes a particular plant or animal looks like, and instead concentrate on the unique identity of that specimen (Leslie, 1995). Biologists recognize the usefulness of drawing and a good deal of time is used on it in the lab, in anatomical and microscopic studies, and in the field. Oddly, biology teachers spend little or no time on students' drawing skills or on how their work will be assessed and graded (Dempsey 2001). Unfortunately, many students fail to master drawing or sketching skills due to the effort and instruction required.

As a result, many students are intimidated by drawing exercises and resort to copying drawings from lab manuals and textbooks (Dempsey, 2001). Several studies have revealed the important role drawing plays in the understanding of several science subjects with special reference to Biology. Among such studies are; Desjean-Perrotta and Utley (2010) that claimed that drawings have been used in science education for almost half a century. Open-ended questions and drawings have been used by several authors to determine the understanding of students at various grade levels with respect to different science concepts: high school students' understanding about the concept of cells by Yörek (2007). All the domains of the students, that is, cognitive, affective and psychomotor are engaged in learning through drawing. These make students to be creative and learn at a deeper level as compared to surface learning (Rogers, 2008). Peggy, Maja, Schwartz and Garner (2006), in their research on learners' generated drawings as a strategy for learning, have found out that making of drawings made learners improve their problem-solving skills apart from improving in examinations performance. Biological drawing as described in the WAEC Chief Examiners' Report

(2021) is different from artistic, architectural, mathematical or geographical drawings. Biological drawing does not involve painting, broken lines, too thick lines, too thin lines, woolly lines but free hand drawing with uniform relatively thin lines. Furthermore, biological drawing as stated in the WAEC Chief Examiners' Report (2018) involved: putting correct title on top or below the diagram; drawing according to the specified size; making labelling horizontal; using ruler to draw all the guide lines; ensure that the guide lines touched the labelled parts; drawing a proportionate diagram and representing cut surfaces in double lines among others. Considering the crucial place of biological drawings in Biology and understanding of other Biology related disciplines such as Medicine, Agricultural science, Anatomy, Physiology, Embryology and Parasitology, the researcher considered it very important to assess the proficiency in biological drawings exhibited by senior high school students in Sekyere South District. The researcher is prompted to assess the proficiency in biological drawings exhibited by senior high school students to identify their strength and weaknesses and find solutions to them and imbue basic principles governing biological drawings. This will therefore enhance as well as arouse their interest in the teaching and learning process of biology.

It was found that, there were surprisingly few research in Ghana's biology drawings that looked into the effects of student gender and school type. Researchers have continued to focus on gender effects, albeit with mixed findings. For instance, the study of Ezirim (2006) observed that gender has significant influence on science achievement while Babajide (2010) found that gender has no significant influence on the students' achievement in science. More so, John (2007) concluded that no significant difference existed in the perceptions of male and female senior high school students in learning of

biology. Thus, studies on gender have remained inconclusive. The location of a school whether rural or urban areas had been identified from various studies as contributor to students' achievement. In the same vein, Ndukwu (2002) and Odinko (2002) noted that schools located in urban areas are better positioned to attract more quality students and teachers who exhibit the readiness to take academic business seriously.

The Category A, B, C, D Schools in Ghana are used by the Ghana Education Service to place students moving from the Junior High Schools (JHS) into Senior High Schools (SHS), Senior High Technical Schools (SHSTS) and Technical and Vocational Institutes (TVIs). This categorization is based on school facilities including well equipped science laboratory, population and academic performance.

Therefore, it is essential to investigate the influence of school type whether grade B or C school in the study area has influence on the proficiency in biological drawing exhibited by Senior High School students in this study.

1.3 Statement of the Problem

A review of students' performance in Biology in the West African Senior High School Certificate Examination (WASSCE) for two decades in Ghana revealed fluctuations and downward trends in students' performance (John, 2021). This has attracted a lot of concern among science educators (Osborne, Simon, & Collins, 2003). In order to achieve the objectives and the aspiration of the government and to improve students' performance in biology, efforts should be directed towards improving teaching and learning of the subject.

Evidences from Chief Examiners Report in 2021, 2020, 2019, 2018 showed that candidates failed to adhere to the guidelines regarding biological drawings and poor drawing skills as a weakness in students performing poorly in the Senior High School Certificate Biology Examinations over the years. Among the reasons adduced was that most of the candidates failed to go by the rubrics regarding biological drawings.

Drawing is an important aspect of biology and every biology student needs a bit of drawing skill if he is to perform well in the subject. The students' knowledge of biology is assessed from three perspectives; the practical, objective and the theory parts and all these aspects involve drawing in one way or the other. Balogun (1994) and Akinmade (1999) attribute the poor performance of students in biology to their inability to tackle biology practical questions which are heavily loaded with drawing activities. A number of authors have also confirmed that senior high school students commit a number of errors in practical biology examination and this affect their performance in the practical examination as well as in the subject as a whole (Nworgu (1999). Against this background, there is the need to update the knowledge of students about what examiners look out for in biology practical examination and questions that require drawing specifically. Adams (1988) in his research work proves that error analysis in biology practical is a useful tool for detecting deficiency in terms of practical skills such as drawing as well as tackling the problems. Brent (2004), Johnson (1990), and Nworgu (1999) identified eight major areas of difficulties or errors encountered by biology students during practical lessons. Out of these eight major errors, five were from drawing and labelling which include:

1. Title of diagram drawn: This ranges from no name or no view of the specimen.

2. Drawing line: Students are found to use woolly or broken lines, use double line or broad single line to represent parts within the diagram.
3. Accuracy of drawings or details: Many students lack the ability to represent special features of specimens drawn.
4. Inability to label parts observed or drawn: Several students are found using double line as guide line to label a single part while others were found using lines that cross one another as guide lines to different parts of the specimen. Many others use lines that do not touch the part they labelled.
5. Magnification: Many students cannot state the exact magnification of the drawing made and many others do not state it at all.

These errors were also identified by the WAEC Chief Examiner for biology (2021, 2020, 2019, 2018). As paramount as the knowledge of biology is to the nation and individuals, it is disheartening that students' achievements in the subject is poor. Furthermore, poor knowledge of drawings has been identified as parts of the factors contributing to poor achievements in biology (Akintola & Ahmed, 2018). The understanding of biology is not possible without the ability of students to draw correctly.

The knowledge of drawing is essential for the understanding of various branches of Biology and some science subjects such as Embryology, Anatomy, Physiology, Genetics, Cytology, Botany, Zoology, Parasitology and other science disciplines such as Medicine, and Genetic engineering (Akintola & Ahmed, 2018). Billiet (2003) claimed that drawing is the result of a long period of observation at different depth of focus. In this study, drawing is considered to involve paying attention to details about

the specimen one is drawing which will enhance the students' knowledge of the specimen. Unfortunately, Motlhabane (2014) study on practical work revealed that biology teachers showed poor attitudes to the teaching of drawings in biology. Apart from poor attitudes of teachers toward teaching of Biology practical, the percentage of marks allotted to drawings in Biology practical is high (WAEC, 2016).

Even though biology knowledge is vital to both the nation and the individual, it is depressing to see how poorly students are performing in the subject. Biological drawing is a clear representation of biology specimens. It has to do with presenting a biology specimen on paper in a form of diagram using pencil. Biological drawing is different from artistic, mathematical, geographical and architectural drawings since there are rules guiding (Lerner, 2007). WAEC Chief Examiners' Report (2021, 2020, 2018) revealed that inability of the students to follow the rules for making biological drawings such as; improper title, poor labelling, making of woolly, broken, too thick or thin lines among others are responsible for students' poor performance in drawings. Looking into the importance of biological drawings, poor performance in the area should be a thing of serious concern to various stakeholders connected with education and national development.

It was discovered that very few studies were recorded in biological drawings in Ghana. Dzidzinyo, Bonney and Sam (2022) examined specific weaknesses exhibited by SHS 3 elective Biology students on biological drawings but influence of Students' Gender and School type were not investigated in the studies. Although biological drawings have been found to be a problem area for students in Ghana, little research on it has been conducted on it. This is unfortunate, given that there is substantial proof that students

better performance in biological drawing can increase students' conceptual understanding and overall achievement in biology (Watters, 2007). Given Ghanaian students' underperformance in biological drawing, it would not be out of place to assess their proficiency level in biological drawing. This study, therefore, sought to fill a knowledge gap in Ghana's educational system regarding assessing the proficiency of Senior High School biology students in biological drawings.

1.4 Objective of the Study

The purpose of this study was to determine the proficiency of Senior High School biology students in biological drawing in selected schools in Sekyere South District.

Specifically, the study determined the following objectives: To;

1. assess the proficiency in biological drawings exhibited by Senior High School students.
2. find out the difference in sex on the knowledge of biological drawings possessed by Senior High School students.
3. determine the influence of school type on the knowledge of biological drawings possessed by senior secondary school students.

1.5 Research Questions

1. What is the level of proficiency exhibited by Senior high school students in biological drawings?
1. 2.What is the difference between male and female senior high school students and their proficiency in biological drawing?
2. 3.What is the influence of school type and the knowledge of biological drawings possessed by senior high school students.

1.6 Significance of the Study

The significance of this study cannot be overstated, as it aims to address a crucial issue in biology education and the negative perceptions and lack of enthusiasm among students towards biological drawing in Sekyere South District. This research holds great importance in dispelling these perceptions and fostering a positive attitude towards biological drawing, which is vital for students pursuing biology at higher academic levels.

Additionally, this study acknowledges the vital role of biological drawing in biology practical examination. By emphasizing the importance of biological drawing which is an important aspect of practical courses in biology, the research aims to enhance students' skills and knowledge, preparing them for future scientific endeavors and contributing to the scientific progress in Sekyere South District.

1.7 Delimitation

There are a number of weaknesses stipulated in the Chief Examiners Report on Biology but this research work focused on biological drawing. The SHS 2 Biology students were chosen for the study because the concept of biological drawing was in section one of the first-year course work and therefore at the time of data collection, it is expected that students in SHS 2 have studied it theoretically and have also undergone practical activities on biological drawing. Moreover, the sampled schools only constituted five out of eight SHSs in Sekyere south District.

1.8 Limitation

The limitation to this research was the fact that no base line measurement was done (pretest) which means that without a pretest, it's harder to know if the groups were equivalent before the intervention or to measure the change in the dependent variable. Another shortcoming could be attributed to the teachers who participated in the research using solely self-report data from the interviews. Their responses on the interviews with respect to what they actually taught the students on the rubrics of biological drawings were not corroborated with first-hand information from classroom observations. It would have been excellent if teachers' actual practices had been seen and contrasted with what was self-reported, even if the purpose of asking students similar questions during the interviews and comparing their answers was to assist triangulate the data. Thus, it is recommended that classroom observations be a part of a future study to examine how teachers teach biological drawing.

1.9 Definition of Terms

Drawing: The representation of living organism on paper, drawing sheet or board using pencil only to show the essential part which is discovered through thorough observation. It does not usually involve shading or painting but compulsorily includes labelling for easy identification of parts and titling.

Biological drawing skills: The expertise of carefully translating visual to visual which is usually evident in quality drawing and labelling. It involves making large drawings, using scales, making only straight lines for labelling and even choosing the right kind of pencil as well as making sure that the pencil is well sharpened

Biology: Biology is the natural science that studies life and living organisms, including their physical structure, chemical processes, molecular interactions, physiological mechanisms, development and evolution.

Proficiency: is a high degree of skill or a thorough competence derived from training and practice.

Achievement: This is also academic performance. It is the grade or score attained by individual students after being subjected to a standardized test.

SHS: Second cycle institutions in Ghana where students are expected to offer various programs based on their future career aspirations.

Specimen: The plant or animal or any other relevant biological substance to be draw

WAEC: West Africa Examination Council

1.10 Organization of the Study

The research work was organized into five chapters. Chapter One which was the Introduction entailed background to the study, statement of the problem, purpose of the study, research questions, significance of the study, delimitations, limitations and definition of terms.

Chapter Two talked about review of related literature. It included introduction to literature review, overview of biological drawing, theoretical framework, overview of biological drawing techniques, impact of laboratory skills on student performance in biology, the importance of biology practical on students achievement in biology, importance of biological drawings and drawing skills, knowledge of the basic principles of drawing among students, factors affecting students' motivation in biological drawing, the effect of gender on drawing skills, interest and achievement in biology, school type

and academic achievement in biology, impact of laboratory skills and practical experience on student performance in biology ,students' attitude towards practical work.

Chapter Three dealt with Methodology which focused on how the study was conducted. It was organized into the following sections: research design, population of the study, sample and sampling procedure, the instrument for data collection, validity of the instrument, reliability of the instrument, data collection procedure and methods of data analysis.

Chapter Four focused on results and discussion of the research work. This includes the findings based on the research questions and the discussion of the research findings. And lastly, Chapter Five which also talked about summary of findings, conclusions and recommendations about the research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

This section provides an overview of the purpose of the literature review and its significance in the context of the study. The main sections of the literature review in this study include: overview to literature review, overview of biological drawing, theoretical framework, overview of biological drawing techniques, impact of laboratory skills on student performance in biology, the importance of biology practical on students achievement in biology, importance of biological drawings and drawing skills, knowledge of the basic principles of drawing among students, factors affecting students' motivation in biological drawing, the effect of gender on drawing skills, interest and achievement in biology, school type and academic achievement in biology, impact of laboratory skills and practical experience on students' performance in biology ,students' attitude towards practical work

2.2 Overview of Biological Drawing

Drawing is an integral component of teaching, learning and evaluation in the field of biology education. It is a basic process skill for the visual representation of biological data. It promotes model-based reasoning, a basic requirement for problem-solving, and analysis of complex and abstract concepts as noted by Quillin and Thomas (2015). Visual modeling is a type of model-based reasoning that is closely linked to drawing. It is the use of graphical languages to graphically represent concepts, objects, and systems to make both novice and expert share a common understanding of the complex concepts, objects, and systems. Models are abstractions that represent the fundamentals

of complex concepts, structures, and problems, through removal of nonessential features, to make the complex concepts, structures, and problems readily understandable to everyone (Mirolo, Izu, Lonati & Scapin, 2022). Drawing provides an avenue to integrate verbal and visual information as it serves as both external and internal mental representation. A combination of visual and verbal information often enhances more meaningful learning than verbal information alone (Shin et al., 2018). Biology teachers frequently make use of drawings as a visual representation to enhance the conceptualization of complex biology concepts. As reported in the work of Liu et al. (2014), biology teachers make use of drawings flexibly to introduce biology topics, explain content knowledge, evaluate students' learning, and integrate it with analogical structures. Emerging literature in science education suggest that students' mastery of biological drawing skills impact their performance in biology (Burns, 2020; Cromley et al., 2015; Ihejiamaizu et al., 2020; Wekesa, 2013). Cromley et al. (2015) reported that students often encounter difficulties in learning from diagrams in their science textbooks and that they often avoid many diagrams in biology. Dempsey and Betz (2001) stated that biology teachers spend little or no time to develop students' drawing skills. Furthermore, Quillin and Thomas (2015) reported that few biology teachers recognize drawing as a teachable science process skill despite the significant role of drawing in visual model-based learning.

Paying attention to improving the knowledge of biological drawings is a rescue move to prevent poor achievements in biology and other fields of studies that their understanding hinged on the knowledge of biological drawings. Kara, Erduran-Avci and Cekbas (2008) revealed that biological drawings could be used to diagnose the quality of students' understanding about a concept. Drawings also break monotony in

teaching, prevents teachers' centeredness, show relationships among different complex concepts in a simpler form, reveal students' previous knowledge about a specimen among others.

Biology as a branch of science studies living things and their interactions with their environment. One of the main objectives of teaching biology according to Ramalingam (2013) is to make students acquire laboratory skills, field skills, and scientific attitudes. This indicates that teaching biology requires both practical and theoretical approaches. According to Iloeje (1991) in Hyelyankuri et al (2017), almost all practical works include making labelled diagrams of the specimen under study. He further explained that theories of biology come from the practical study of specimens, and new ideas are also discovered as a result of practical work.

Drawings and diagrams are an essential part of communication in science and especially biology. Remember it is not an artwork or sketch! But rather it is a clear representation of what you observe which can be used to interpret what you saw. Biological drawing may also be referred to as lab drawing. According to Biology for life (2012), a drawing is the result of a long period of observation at different depth of focus and at different magnifications. OCR' (2015) argues that in assessing biological drawing, marks are awarded for both the quality of drawing and labelling. The latter may include annotation.

According to Billiet (2003), scientific drawing is a very important skill in biology, it helps in data recording as well as highlights important features of a specimen, and probe mental models of biological concepts that students have; therefore, drawing is a

necessary skill in passing biology. Scientific drawings are an important part of the science of biology and all biologists must be able to produce good quality scientific drawings regardless of your artistic ability.

Many students taking Biology are intimidated by "Biological Drawing" and many takes this lightly. Actually, to do a biological drawing one does not have to be an artist. You are not expected to produce a masterpiece. What is important here is to draw a given specimen as accurately as possible. Whether you like it or not, you will have to do it one way or another.

2.3 Theoretical Framework

2.3.1 Vygotsky's Social Constructivist Learning Theory

Lev Semenovich Vygotsky is one amongst those who believe that children actively construct their knowledge through active engagement with their environment; this would represent learning materials in a collaborative process. Vygotsky (1962) viewed cognitive development as where the child learns through shared problem-solving experiences with someone else, such as teachers and peers hence knowledge mutually built and constructed. It emphasized that individual will facilitate transition from learners' zone of proximal development to new levels of skills and competences. Zone of proximal development (ZPD) is Vygotsky's term for the range of tasks that are too difficult for children to master alone, but can be learnt with the assistance from adults or more skilled children working independently. It is different from what the student already knows rather it focuses on the student's potential This implies that the science teacher should act as a facilitator by gradually withdrawing explanation, hints and demonstrations until the student is able to perform the skill alone. This will encourage

the students to learn from previous knowledge they had before coming to school or the knowledge they already have to build the new knowledge. This theory is related to this present work because it encourages the development of skills through student interaction with the materials: the specimen to be drawn or with one another. It is also related to this study because it recognizes the importance of students' previous understanding of subject. In this case, students are assumed to be I the ZPD for making logical drawing so can almost, but not quite, show all skills on their own but with the right kind of guidance, however can do it successfully.

This research is embedded in constructivist paradigm. Although it has become popular only recently, the origins of constructivism are believed to date back to the time of Socrates, who claimed that teachers and learners should talk with each other and interpret and construct the hidden knowledge by asking questions (Hilav, 1990, cited in Erdem, 2001). Gruber and Voneche (1977) also state that the term constructivism most probably is derived from Piaget's "constructivist" views (1967), as well as from Bruner's (1996) "constructivist" description of discovery learning. Furthermore, Perkins (1992) points out that constructivism has multiple roots in psychology and philosophy of this century: the developmental perspective of Jean Piaget (1969) and the emergence of cognitive psychology under the guidance of figures like Jerome Bruner (1966).

Constructivism is a synthesis of multiple theories diffused in to one form. It is the assimilation of both behaviorist and cognitive ideals. The "constructivist" stance maintains that learning is a process of constructing meaning; it is how people make sense of their experience" (Merriam & Caffarella, 1999, p. 260). Mvududu and Thiel-

Burgess (2012) stated that constructivism is widely touted as an approach to probe for children's level of understanding and to show that understanding can increase and change to higher level thinking. Constructivism describes the way that the students can make sense of the material and also how the materials can be taught effectively. With Constructivism as an educational theory in mind, the teachers should consider what students know and allow their students to put their knowledge in to practice.

Kanselaar (2002) stated that there are two major strands of constructivist perspective, (a) cognitive constructivist perspective and (b) social-cultural perspective (Socio-constructivist perspective).

- a. Cognitive constructivism, an individualistic perspective is based on the work of Swiss developmental psychologist Jean Piaget. Piaget's theory includes two major parts, a "ages and stages" component that predicts what children can and cannot understand at different ages, and "theory of development" that describes how children develop cognitive abilities. Piaget (1977) asserts that learning does not occur passively; rather it occurs by active construction of meaning. He explains that when we, as learners, encounter an experience or a situation that challenges the way we think, a state of disequilibrium or imbalance is created. We must then alter our thinking to restore equilibrium or balance. For this purpose, we make sense of the new information by associating it with what we already know, that is, by attempting to assimilate it into our existing knowledge. When we are unable to do this, we use accommodation by restructuring our present knowledge to a higher level of thinking.

- b. Social-cultural constructivism (Socio-constructivist perspective) Lev Vygotsky's (1868-1934) main relevance to constructivism comes from his theories about language, thought, and their mediation by society. Vygotsky holds an anti-realist position and states that the process of knowing is affected by other people and is mediated by community and culture. An important part of Vygotsky's work (1986) is critical upon Piaget's contribution to constructivism. While Piaget believes that development precedes learning, Vygotsky believes the opposite. On the topic of the development of speech, Piaget said that the children's egocentric speech goes away with maturity and is transformed into social speech. On the contrary, Vygotsky stated that the child's mind is inherently social in nature and so speech moves from communicative social to inner egocentric. Therefore, since the development of thought follows the development of speech, Vygotsky claims that thought develops from society to the individual and not the other way.

Constructivism as an educational theory holds that teachers should first consider their students' knowledge and allow them to put that knowledge into practice (Mvududu & Thiel-Burgess, 2012). In other words, Mvududu and Thiel-Burgess represent constructivist view as one of the leading theoretical positions in education. Since there is no universal definition of constructivism, some consider it as a theory of learning, others as a theory of knowledge; although some other scholars and theorists consider it as a theory of pedagogy. Additional views are theory of science, educational theory or an all-encompassing worldview. Cooper (1993) states that like psychology, there has been a paradigm shift in the designed instruction which can be described as a shift from behaviorism to cognitivism and then from cognitivism to constructivism. This

paradigm shift indicated that the field of education itself has undergone a significant shift in the nature of human learning and the conditions that best promote the different conditions of learning. Cooper also proposes that constructivist perspective on learning have become so influential in the past twenty years that they represent a paradigm shift in the epistemology of knowledge and theory of learning. Phillips (2000) writes about a number of constructivist traditions. He proposes that educational constructivism itself includes a number of variations and the two most popular types of these variations are: 1) Jean Piaget's personal constructivism 2) Lev Vygotsky's social constructivism Piaget and Inhelder (1969) suggest that discovery is the most important and fundamental basis of learning. While Vygotsky (1978) believes that Piaget's emphasis focuses too much on internal processes of individuals. Vygotsky considers cognitive development primarily as a function of external factors such as cultural, historical, and social interaction rather than of individual construction. Vygotsky believes that people master their behavior through psychological tools and he introduces language as the most important psychological tool. Many educators such as Bailey and Pransky (2005) agree with Vygotsky (1978) about the importance of culture in construction of knowledge, yet Bailey and Pransky (2005) emphasize that pedagogical theories such as constructivism don't consider the deep impact of culture on learning and knowledge. However, the following parts show whether knowledge is viewed as individual construction has implications for the ways in which learning is conceptualized, it has implications for the ways in which learning is conceptualized (Mvududu & Thiel-Burgess, 2012).

Due to complexities and diversity of perspectives on constructivism, Hoover (1969) introduces a common set of principles for these perspectives that can be

operationalized. Hoover expressed two important notions which encompass the simple idea of constructed knowledge. The first notion is that learners construct new understandings using their current knowledge. In other words, the learners' prior knowledge influences their new knowledge. The second notion is that learning is not passive. Instead, learning is an active process in which learners negotiate their understanding in the light of what they experience in the new learning situation. If what learners encounter is not consistent with their current understanding, their current knowledge can change in order to accommodate new experience. Thus, learners cannot be passive and they remain active throughout this process. Cook (1992) also advocates the use of negotiation in the curriculum. When learners negotiate, ask questions, and try hard to find the answers themselves, what they learn will be more meaningful to them (Cook,1992). In this curriculum, a sense of ownership in learners for their work and a commitment to their learning can occur. Bruner (1992) comments on negotiating the curriculum as Negotiating the curriculum means deliberately planning to invite students to contribute, and to modify, the educational program, so that they will have a real investment both in the learning journey and the outcomes. Negotiation also means making explicit, and then confronting, the constraints of the learning context and the non-negotiable requirements that apply. Fosnot (1989) defines constructivism according to four principles:

1. learning depends on what individuals already know.
2. new ideas occur as individuals adapt and change their old ideas.
3. learning involves inventing ideas rather than mechanically accumulating a series of facts.
4. meaningful learning occurs through rethinking old ideas and coming to new conclusions about new ideas which conflict with our old ideas.

In constructivism, learning is represented as a constructive process in which the learner is building an internal illustration of knowledge, a personal interpretation of experience. This representation is always open to modification, its structure and linkages forming the ground to which other knowledge structures are attached. Learning is then an active process in which experience has an important role in understanding and grasping the meaning. This view of knowledge does not necessarily reject the existence of the real world, instead it agrees that reality places constrain on the existing concepts, and contends that all individuals' knowledge of the world is the interpretations of their experiences.

Furthermore, conceptual growth is the result of various perspectives and the simultaneous changing of individuals' internal representations in response to those perspectives as well as through their experience (Bednar, Cunnigham, Duffy & Perry, 1995 cited in Duffy & Jonassen,1991). Christie (2005) points out that constructivism is a learning theory in which learning is both an active process and a personal representation of the world. In this theory, knowledge is constructed from experience and is modified through different experiences. Problem solving and understanding are emphasized in this theory. Authentic tasks, experiences, collaboration, and assessment are among other important factors in this view of learning. Hare (2005) stated that learner-centric instructional classroom methods are emphasized in the constructivist learning approach. Also Hare (2005), argue that educators who follow this approach must build their school curriculum around the experience of their students. Hare stated that there is a trend for incorporating technology into the classrooms in order to support instructional learning methods. However recent studies have revealed that technology is not efficiently integrated with the constructivism and constructivist leaning. Piaget's

constructivism which is based on his view of children's psychological development insists that discovery is the basis of his theory. Piaget (1973) argues that to understand means to discover or reconstruct by means of rediscovery. Piaget discusses that child go through stages in which they accept ideas they may later change or do not accept. Therefore, understanding is built up step by step through active participation and involvement and learners cannot be considered as passive in any of the steps or stages of development. Contrary to Piaget, Bruner (1973) states that learning is a social process, whereby students construct new concepts and knowledge based on their current knowledge. In this view of constructivism, the student selects information, constructs hypotheses, and makes decisions, with the aim of integrating new experiences into his existing knowledge and experience. Bruner emphasizes the role of cognitive structures for providing meaning and organization of experiences and suggest learners to transcend the boundaries of the given information. For him, learner independence lies at the heart of effective education and he argues that this independence can be increased when the students try to discover new principles of their own. Moreover, curriculum should be organized in a spiral manner so that students can build upon what they have already learned.

According to Prawat (1992), most of the interpretations of the meaning of constructivist theory agree that it involves a dramatic change in the focus of teaching and puts the students' own efforts to understand at the center of the educational enterprise. Gray (1997) proposes that constructivist teaching is based on the learning that occurs through learners' active involvement in construction of meaning and knowledge. Constructivist teaching just promotes learners' motivation and critical thinking, and encourages them to learn independently. Hoover (1996) argues that constructivism has important

implications for teaching. First, teaching cannot be viewed as the transmission of knowledge from enlightened or known to unenlightened or unknown. Constructivist teachers are not monologue teachers who just teach completely new lessons. Rather constructivist teachers have the role of guides for the students and provide their students with opportunities to test the adequacy of their current understandings. Second, constructivist teachers consider the prior knowledge of their learners and provide learning environments that exploit inconsistencies between learners' current knowledge and their new experiences (Clements, 1997; Hoover, 1996). The difference between learners challenges the teachers and does not allow them to use the same method or the same materials while teaching to these students. Third, since learners' involvement is emphasized in the constructivism, the teachers must engage students in learning, and bring their students' current understanding to the forefront (Hoover, 1996). Constructivist teachers can ensure that learning experiences include problems that are important to the students, and are not just related to the needs and interests of teachers and the educational system. Fourth, Hoover (1996) reminds that sufficient time is needed to build the new knowledge actively.

During this time, the students reflect on their new experiences and try to consider the relationship between these experiences and the previous ones in order to have an improved (not "correct") view of the world. Similar to the effect of negotiation as an important aspect of a constructivist classroom on learning, negotiation also unites teachers and students in a common purpose. Smith (1993) confirms that negotiating curriculum means "custom-building classes every day to fit the individuals who attend" (p. 1). Bruner (1992) reminds that teachers must talk openly about the new knowledge and constraints in the negotiations.

Constructivism believes that learner's conceptions of knowledge are derived from a meaning-making search in which learners construct individual interpretations of their experiences. The learners' constructions during the examination, questioning and analyzing of tasks and experiences yield knowledge whose correspondence to external reality may have little verisimilitude.

However, most of the learners' constructions is filtered through a process of social negotiation or distributed cognition (Brown, Ash, Rutherford, Nakagawa, Gordon & Campione, 1995). Applefield, Huber, and Moallem (2000) point out that the role of the learner in constructivism is conceived as building and transforming knowledge. Although, Applefield, Huber, and Moallem (2000) reminded that there are different notions of the nature of knowledge and knowledge construction process, Moshman (1982) identifies three types of constructivism as exogenous constructivism, endogenous constructivism and dialectical constructivism. Exogenous constructivism, which is related with philosophy of reality, proposes that the learner constructs and reconstructs mental representations which reflect the organization of the world. In this view, the learners' schemata and networks of information are based on the external realities of the environment that they experience. Endogenous or cognitive constructivism is based individual construction of knowledge (Cobb, 1994; Moshman, 1982). This type of constructivism is derived from Piagetian theory (1977, 1970) and describes how individuals can resolve mental disequilibrium when they encounter internal cognitive conflict. Learners' negotiation on the meaning of their experiences and use of individual or socially mediated discovery-oriented learning activities are emphasized in this perspective.

Furthermore, Applefield, Huber, and Moallem (2000) introduce the importance of collaborative social interaction and context in social or dialectic constructivism. Social constructivism represents the most general extant perspective of constructivism with its emphasis on social exchanges for learners' cognitive growth and role of culture and history in their learning.

In constructivism, teachers and peers support and contribute to learning through the concepts of scaffolding, cognitive apprenticeship, tutoring, and cooperative learning and learning communities (Brown, 1994; Rogoff, 1998). In a constructivist classroom, teachers create situations in which the students will question their own and each other's assumptions. So, a constructivist teacher needs to create situations that challenge the assumptions of traditional teaching and learning. Belenky, Clinchy, Goldberger, and Tarule (1986) cited in Gray (1997) report that at the constructivist level of knowing and thinking, we always reevaluate our assumptions about knowledge; our attitude towards "the expert" is transformed; we do not have any problem by ambiguity but are enticed by complexity; and we take on a never-ending quest for truth and learning where truth is seen as a process of construction in which the knower participates.

A constructivist teacher's perception of expertise in the classroom is based on the experience of his or her students in interaction with each other and with their teacher, and his or her tolerance of ambiguity is high as evidenced in the tendency to create complexity. Lester and Onore (1990) indicated that teachers' personal beliefs about teaching (their construct systems) are important and determine the kinds and extents of changes they are able to make. Also, Lester and Onore stated that teachers view teaching and the situation through the lens of their personal construct system. Thus, the

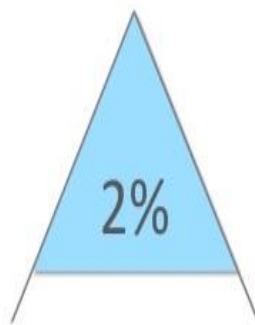
main construct affecting a teacher's ability to teach in a transactional, constructivist way is the belief that knowledge is constructed by human beings. Further, teachers would need to make a shift in thinking and change what they believe about knowledge in order to really change their teaching. According to Mezirow (1990) cited in Gray (1997), reflecting on teaching practice contributes to the teacher's ability to cross the bridge in terms of how he or she thinks and believes about teaching. This enables the teacher to move, for example, from a transmissional instructional practice, which is common in the traditional teaching to a constructivist and transactional one, which is the purpose of constructivism). Reflection also involves a critique of the assumptions on which the teachers' beliefs have been built, and through reflection, their perspectives are transformed Lester and Onore (1990) propose that genuine learning or change does not come from ignoring all prior learning in order to relearn, but "from questioning or reassessing our existing beliefs about the world" (p. 41): Change can occur through having experiences that present and represent alternative systems of beliefs and trying to find a place for new experiences to fit into already held beliefs (p. 41). Giroux (1986) notes that teachers are often trained to use various models of teaching and evaluation, yet are not taught to be critical of the assumptions that underlie these models. He advises that teachers must be more than technicians but transformative intellectuals engaging in a critical dialogue among them.

Lester and Onore (1990) note that holding a constructivist view of knowledge can enable a teacher to explore and form new ideas about teaching and learning. But the teacher's job in holding this view may need more attention when he or she has to consider all that impinges on teaching such as the existing school system and its policies, and the school culture. As one of the instances of the effect of constructivism

on teaching, Carpenter and Fennema (1992) in their Cognitively Guided Instruction (CGI) of mathematic program stated that elementary school teachers were given extensive training in constructivist methods such as complex problems, modeling, group problem solving, and teaching of metacognitive strategies and these teachers have improved in higher level thinking skills as well as solid achievements in traditional computational skills. Neale, Smith, and Johnson (1990) declare that in addition to positive outcomes of constructivism in science (Neale, Smith, & Johnson,1990), similar successes have been reported in reading (Duffy & Roehler, 1986) and in writing (Bereiter & Scardamalia, 1987).

2.3.2 Kokcharovs', Hierarchy of Skills

According to Kokcharov (2015), hierarchy of skills placed craftsman which encapsulates drawing skills on the highest hierarchy just where self-actualization is placed by Abraham Maslow. This implies two things; drawing brings about self-actualization and secondly only 2% of people reach this level.



▪ Maslow said only 2% of people reached the stage of self-actualization.

▪ The same percentage can be attributed to the highest level of the Skill Hierarchy.



Craftsman is rare species



The role of drawing skills in the teaching and learning of Biology has often been underestimated. Schonborn and Anderson (as cited in Lerner, 2007) argue that the pedagogical importance of visual literacy and visualization in biology and especially in the education of biochemistry has been ignored for a long time. Khan, Mei, and Wilson (1992). notes that very little research has been done on understanding the function of drawing in children's writing and learning processes. The use of visual representations to learn can be traced to Louis Agassiz, Harvard Professor of Zoology. In his approach, students were to study nature through carefully observing, drawing and making inferences (Lerner, 2007). In Biology, the study of life requires careful observation and description. One excellent way to describe an object is to draw it. The goal of the observer is normally to move beyond simple mental images of what he/she believes a particular plant or animal looks like, and instead concentrate on the unique identity of

that specimen (Dempsey et al., 2001). Such approaches to learning in Biology will help students relate structure to function to a great extent.

Aggarwal (2001) says that the making of drawings in botany and zoology is an accepted technique. He noted that drawing in Biology has the following functions:

- a) Ensure that the pupil looks at and examines the details of the specimen with proper attention. This ensures meaningful learning which will be translated into good performance in Biology.
- b) To provide avenues for learning through visual and kin aesthetic experience in addition to the auditory experience of listening to the teacher. This breaks monotony during the learning process resulting in increased attention span.
- c) To provide a record of the work done by the pupil
- d) To provide the pupil with material useful for revision.

2.3.3 The Use of Mastery Learning for Developing Drawing Skills

Learning a skill requires practice, being in the psychomotor domain it requires good learning environment, quality instructional material, qualified teacher, and the interest of the students. The major problem behind lack of drawing skills or other skills in biology is described by (Kadiri, 2019) as the use of discipline-based teaching, she opined that the need/concern and the requirements of teachers and students are not considered because the subject content is driven by, and depends mainly on the disciplinary content that must be presented. It is also not uncommon to say teachers focus only on the cognitive domain in their objectives, method used and their evaluation questions but the teaching of drawing requires attention to both the cognitive, affective

and psychomotor domain. The method of teaching that emphasizes practice is mastery learning.

Mastery learning (or, as it was initially called, "learning for mastery") is an instructional strategy and educational philosophy, first formally proposed by Benjamin Bloom in 1968. Mastery learning maintains that students must achieve a level of mastery (e.g., 90% on a knowledge test) in prerequisite knowledge before moving forward to learn subsequent information. If a student does not achieve mastery on the test, they are given additional support in learning and reviewing the information and then tested again. This cycle continues until the learner accomplishes mastery, and they may then move on to the next stage.

Mastery learning methods suggest that the focus of instruction should be the time required for different students to learn the same material and achieve the same level of mastery. This is very much in contrast with classic models of teaching, which focus more on differences in students' ability and where all students are given approximately the same amount of time to learn and the same set of instructions.

2.4 Overview of Biological Drawing Techniques

The scientific field of biology examines living organisms and how they interact with their surroundings. One of the main objectives of teaching biology according to Ramalingam (2013) is to make students acquire laboratory skills, field skills, and scientific attitudes. This suggests that teaching biology calls for a combination of theoretical and practical methods. According to Iloeje (1991) in Hyelyankuri et al (2017), most practical tasks involve labeling diagrams of the specimen being studied.

He went on to say that biological theories are derived from the actual examination of specimens, and that practical research also yields new concepts.

Drawings and diagrams are an essential part of communication in science and especially biology. Remember it is not an artwork or sketch! But rather it is a clear representation of what you observe which can be used to interpret what you saw. Biological drawing may also be referred to as lab drawing. According to Biology for life (2012) a drawing is the result of a long period of observation at different depth of focus and at different magnifications. (OCR, 2015) argues that in assessing biological drawing, marks are awarded for both the quality of drawing and labelling. The latter may include annotation.

According to Billiet (2003), scientific drawing is a very important skill in biology, it helps in data recording as well as highlights important features of a specimen, and probe mental models of biological concepts that students have; therefore, drawing is a necessary skill in passing biology. Scientific drawings are an important part of the science of biology and all biologists must be able to produce good quality scientific drawings regardless of your artistic ability.

Many students taking Biology are intimidated by "Biological Drawing" and many takes this lightly. Actually, to do a biological drawing one does not have to be an artist. You are not expected to produce a masterpiece. What is important here is to draw a given specimen as accurately as possible. Whether you like it or not, you will have to do it one way or another.

2.5 Impact of Laboratory Skills on Students Performance in Biology

According to WAEC Chief Examiners Report (2018), the observed weakness includes:

- i. Inability to relate structure with function of specimens
- ii. Poor spelling of technical term and one-word answer e.g., anthropoda, atropoda, arthropodia instead of arthropoda and isecter instead of insecta
- iii. Starting taxonomic names with small letters
- iv. Breaking a single technical word into two words e.g., house fly for housefly
- v. Inability to title diagram correctly
- vi. Poor diagram of a specimen (specimen k) pride of Barbados flower
- vii. Not including the magnification of the diagram
- viii. Using unruled or crossing guidelines in labeling diagrams;
- ix. Using plural instead of singular for a single guideline
- x. Using guidelines that do not match the structure;
- xi. Making diagrams without the correct specifications;
- xii. Labeling with guideline that are not ruled;
- xiii. Drawing the wrong specimen and drawing off-hand making their have little or no link with the question asked
- xiv. Inability to mention specific habitats of organisms
- xv. Inability to tabulate answers on differences
- xvi. Inability to compare two specimens correctly. Pride of Barbados flower and elephant grass (specimens K and L respectively)

Other common error is overlapping lines.

All these common errors can be linked directly to the lack of adequate laboratory experience. Most schools give their students access to the laboratories when it is time

to prepare for external examinations only. The laboratories in most schools lie fallow as the reason for building them in the first instance was to get accreditation from the government. Enebechi (2009) stated that some biology teachers fail to conduct biology practical along-side every topic treated during lessons, until a few days to examination when they will use WAEC specimens to conduct practical for their students. Laboratory activities are important in developing biological skills. Laboratory activities also provide opportunities to collect and analyze data and apply mathematical knowledge to support and illustrate concepts, facts and principles (Garnett, 2005; Lunetta, 2008). Laboratory practical works provide a way not only for developing varieties of different practical skills but also developing favorable attitudes, interest, pleasure, enthusiasm, imitation, imagination and cooperation among students (Nworgu, 2009),

Bajon (2015) found out that, students taught biology using group laboratory activity performed better than their counterparts, taught biology using individual laboratory activity. He also stated, students who work cooperatively perform better than their counterparts who work individually. When students work in group to generate their own question, analyze and discuss their findings and finally organize their thoughts, they seem to understand their own information better than the ones the teachers introduced to them or the ones that they generate individually. Schools grouping students is the common practice of class management when conducting practical lessons in large classes (Edson, Mwangi, Lwazi & Sibanda, 2017).

Experimental activities in Biology could be seen as a method that could be adopted to make the task of teaching Biology more concrete or real to students as opposed to theoretical or abstract presentation of principles, facts and concepts. Experimental

activities in Biology are important to students' academic performance because, it is a teaching method that has to do with practical demonstration of scientific concepts, principles, theories and laws. From its experimental engagement, the students ultimately gain capacity to acquire new facts, develop concepts and principles and skills, which lead to the cultivation of scientific attitudes and habits (Onyegegbu, 2006). For instance, practical activity on the influence of carbon (iv) oxide on photosynthesis, offer students the opportunity of collecting relevant data and conceptualizing on the appropriateness of the theories associated with photosynthesis and carbon (iv) oxide. It is in view of the above that, Nwagbo (2016) stated that "the used of practical activities approach to the teaching and learning of Biology concepts should therefore be made mandatory other than an option to Biology teachers, if we hope to produce students that would be able to acquire the necessary knowledge, skills and competence needed to meet the demands of the nation". This implies that, the academic performance of students in any science-based subject like Biology is closely related to both theoretical and practical knowledge.

2.6 The Importance of Biology Practical on Students' Achievement in Biology

This section discusses the importance of practical work in biology education, highlighting its role in developing science process skills, promoting meaningful learning, and enhancing students' understanding of biological concepts. Practical work holds a significant place in biology education as it serves various purposes in the teaching and learning process. It provides students with opportunities to engage in hands-on activities, enabling them to develop essential science process skills, promote meaningful learning, and enhance their understanding of biological concepts (Olumorin, Babalola & Ayoola, 2022). This section discusses the importance of

practical work in biology education, highlighting its role in skill development, meaningful learning, and concept comprehension.

One of the primary benefits of practical work in biology education is the development of science process skills. Science process skills refer to a set of critical thinking and problem-solving skills that are essential for scientific inquiry (Kurniawan, Perdana, & Ikhlas, 2020). Through practical work, students actively participate in scientific investigations, conducting experiments, making observations, collecting data, and drawing conclusions (Liswaniso, 2019). By engaging in these activities, students develop skills such as critical thinking, logical reasoning, data analysis, and experimental design, which are vital for scientific literacy and future careers in science-related fields.

Furthermore, practical work promotes meaningful learning by providing students with concrete experiences that connect theory to real-world applications. Biology concepts can often be abstract and complex, making it challenging for students to grasp their practical relevance. Practical work allows students to bridge this gap by actively engaging with the subject matter. By conducting experiments and directly observing biological phenomena, students can link theoretical concepts to tangible outcomes, deepening their understanding and creating meaningful connections (Drake, 2012). Practical work also enhances students' understanding of biological concepts by promoting active learning (Ballen, Wieman, Salehi, Searle, & Zamudio, 2017). Rather than passively receiving information from textbooks or lectures, students become active participants in their learning process. They explore, investigate, and manipulate materials, allowing for a more comprehensive and experiential understanding of

biological principles. This active engagement helps students construct their knowledge, fostering a deeper understanding that extends beyond rote memorization.

Additionally, practical work encourages the development of important laboratory skills and techniques. Students learn how to handle scientific apparatus, measure accurately, and follow experimental procedures. These skills are transferable and applicable in various scientific disciplines, equipping students with valuable laboratory competencies that can be utilized in future academic pursuits and professional endeavors (Solé-Llussà, Aguilar, & Ibáñez, 2022).

Moreover, practical work fosters the development of teamwork and collaboration skills. In many biology experiments, students work in groups, encouraging cooperation, effective communication, and the ability to work harmoniously towards a common goal. Collaboration enhances the learning experience by exposing students to diverse perspectives, promoting discussion and critical thinking, and encouraging peer-to-peer support (Karacop & Diken, 2017). These interpersonal skills are not only valuable for biology education but are also essential for success in many professional settings. Despite the numerous benefits, it is important to acknowledge the challenges associated with implementing practical work in biology education. Limited resources, time constraints, and large class sizes can pose significant obstacles to providing meaningful practical experiences for all students (Ching *et al.*, 2018). Additionally, ensuring safety protocols and ethical considerations in the laboratory setting is of utmost importance to guarantee the well-being of students and minimize potential risks.

Despite the challenges, educators and researchers continue to emphasize the importance of practical work in biology education due to its unique advantages. Practical work serves as a bridge between theoretical knowledge and its practical application, enabling students to witness firsthand the relevance and significance of biological concepts in real-world contexts (Jacobson, McDuff, & Monroe, 2015).

One of the key advantages of practical work is its ability to promote inquiry-based learning. By engaging in hands-on activities, students develop their curiosity, critical thinking, and problem-solving skills. They learn to ask questions, design experiments, analyze data, and draw conclusions, mirroring the processes used by scientists. This inquiry-based approach fosters a deeper understanding of biology by encouraging students to actively explore and discover knowledge for themselves (Shah & Martinez, 2016).

Furthermore, practical work allows students to develop important laboratory techniques and skills. In a controlled laboratory environment, students learn proper handling of equipment, measurement techniques, and experimental procedures (Gamage *et al.*, 2020). These skills not only enhance their scientific knowledge but also prepare them for future scientific studies or careers in research.

Practical work also promotes the development of scientific literacy, as students learn to evaluate and interpret scientific information. Through practical activities, students engage in critical analysis of data, drawing conclusions based on evidence and scientific reasoning (Sutiani, 2021). This enables them to become informed citizens who can

make sound decisions and contribute to discussions on scientific and environmental issues.

Moreover, practical work provides a platform for collaborative learning and teamwork. Students often work in groups to conduct experiments, share ideas, and troubleshoot problems. This collaborative environment fosters effective communication, negotiation, and cooperation skills, which are vital for success in a professional setting. By working together, students learn from each other's perspectives, build on shared knowledge, and develop a sense of camaraderie (Roy, P. K., 2024).

Another advantage of practical work is its ability to cater to diverse learning styles. Not all students learn best through traditional classroom lectures or textbook readings. Practical activities provide an alternative approach that accommodates different learning preferences. Visual learners benefit from observing biological phenomena directly, while kinesthetic learners thrive in hands-on activities that involve manipulation of materials. Practical work allows students to engage with biology in a way that suits their individual learning style, enhancing their overall learning experience (Sousa & Fontão, 2020).

2.7 Importance of Biological Drawings and Drawing Skills

Drawings not only allow you to record an image of the specimen observed, but more importantly, they help you to remember the specimen as well as the important features of the specimen. You will be required to look at a large number of specimens while studying this course; biology and you are much more likely to remember them if you have to draw each one. Drawing a specimen requires you to pay attention to detail so

that you can re-create it on the sheet. While doing this, your brain is recording these same features in such a way that you can recall them if necessary (for example in an exam). Simply observing pictures of specimens in a book or on a computer screen is less effective when it comes to remembering and understanding what you observed. All drawings done in biology must adhere to standard rules of scientific illustration. You may sometimes think that biological drawing is ridiculous but actually it is training and testing your power of observation. Having a strong power of observation is one characteristic that a future scientist must have. It helps you to be more pertinent in your future work. For example, if you want to be a forensic scientist, having a strong power of observation is very important in solving a problem.

The word skill is synonymous to ability, competence, know-how, adroitness, expertise. According to Merriam Webster dictionary (2020), skill is dexterity or coordination especially in the execution of learned physical tasks. There are skills in drawing generally as much as biological drawings have specific skills that differentiate it from the usual artistic drawing. A biological drawing skill is categorized as a hard skill. According to Wikipedia (2020), hard skills, also called technical skills, are any skills relating to a specific task or situation. It involves both understanding and proficiency in such specific activity that involves method, processes, procedures or techniques, these skills are quantifiable. These skills can be tested, and may entail some professional, technical, or academic qualification.

(Kokcharov, (2015) asserted that, hierarchy of skills placed craftsman which encapsulates drawing skills on the highest hierarchy just where self-actualization is

placed by Abraham Maslow. This implies two things; drawing brings about self-actualization and secondly only 2% of people reach this level

2.8 Knowledge of the Basic Principles of Drawing among Students

All the techniques discussed above can be summarized into the following; making proportional drawings, Cutting of Correct Sections, Drawing Continuous Outline of Specimen, Use of Pencil in Drawing, Shading Drawings of Specimen (not shading), Calculation of Magnification (Wekesa, An Assessment of How Students' Mastery of Drawing Skills in Secondary Schools Affects Performance in Biology in Bungoma West District, Kenya (2013), Titling the drawing of the specimen (OCR, 2015).

Making proportional drawing; a proportion is a part compared to a whole specimen and making a proportional drawing is important in morphological drawings (drawing of life) than in ecological drawings (lifeless environment of living organisms). For example, the gill rake is the same size as the gill filament and should be drawn showing that exact proportion but students who lack this skill draw the gill rake smaller than the gill filament. Wekesa (2013) (p.529) attributes the lack of this skill among students to:

- a. Lack of observation skills: The learners are not keen enough to take into consideration the size of a given structures in relation to other structures.
- b. Lack of practice in making of biological drawings
- c. Theoretical approach to teaching and learning of biology. The learners are not exposed to practical which require them to make drawings.
- d. In the case where drawing is done, the teachers do not assess the students' work with a view of correcting the drawing mistakes committed.

Cutting of Correct Sections; the internal part of any specimen cannot be drawn if the specimen is not cut into sections. The section that a specimen is cut into determines how it will be viewed. Cutting a correct section although not directly related to biological drawings but cutting a wrong section affects the drawing (Wekesa, 2013). Usually, examiners state the section that a student should draw and score is usually not awarded to students who draw a wrong section even if the drawing correctly shows high level of biological drawing skill. The most common section that specimen is cut into are transverse and longitudinal, others include tangential and oblique.

Drawing Continuous Outline of Specimen; Lumen (2019) opines that drawing continuous outline means keeping a drawing as simple as possible by drawing with strong unbroken lines. He further recommends that one should not draw background or unnecessary details. Students are not able to draw a continuous outline because they always compare the drawings in their textbooks with the specimen they are to draw. As much as it is very important to consult textbooks before checking the specimen (whether with the help of microscope or naked eyes), students should restrict their drawings to only what they see.

Use of Pencil in Drawing; as earlier stated, pencil is essential for the purpose of making correction. Most students have learnt by experience that drawing with pencil is the right tool for making biological drawing but most of them still use a pen because they are either non-challant, or do not have a pencil.

Titling the drawing of the specimen; the title of drawing is very necessary for proper identification. Students rarely title their drawing, when they do, it is wrongly written

Shading drawings of specimen; Shading drawings in pencil drawings allows the drawing to communicate volume (Fussell, 2019) and this is not needed in a biological drawing as it leads to congestion of structure. The only form of shading allowed in a biological drawing is stippling which is the use of small dots. The use of dots in illustrating some parts of a specimen is inevitable as in the case of drawing the petals of *Calochortus luteus* (the yellow mariposa lily) hatching according to Allan, Reed & Weyers (1994), as seen in Wekesa (2013) can also be used, but in very few occasions.

2.9 Factors Affecting Students' Motivation in Biological Drawing

Motivation plays a crucial role in students' engagement and performance in biological drawing. This section examines the factors that influence students' motivation in the context of drawing tasks, including intrinsic and extrinsic motivators, self-efficacy beliefs, task value, and the influence of the learning environment.

Intrinsic motivation refers to the internal drive and interest that individuals have in engaging in an activity for its inherent satisfaction and enjoyment (Filgona *et al.*, 2020). Students who are intrinsically motivated in biological drawing are more likely to exhibit higher levels of engagement, effort, and perseverance. They find biological drawing tasks personally meaningful, challenging, and aligned with their interests and goals. Intrinsic motivation can be nurtured by providing opportunities for student choice and autonomy, promoting curiosity and inquiry, and emphasizing the real-world relevance of biological drawing.

Extrinsic motivators, such as grades, rewards, and recognition, also influence students' motivation in biology biological drawing. While external rewards can provide short-

term motivation, they may not sustain long-term engagement or promote deep learning. The use of extrinsic motivators should be balanced with an emphasis on the intrinsic value biological drawing. Creating a supportive and non-competitive environment where students feel encouraged and valued for their effort and progress can help foster intrinsic motivation (Malone & Lepper, 2021).

Self-efficacy beliefs, which refer to students' confidence in their ability to perform specific tasks, have a significant impact on their motivation in biological drawing (Shin, 2018). Students with high self-efficacy beliefs are more likely to approach drawing practical tasks with a positive attitude, invest effort, and persist in the face of challenges. On the other hand, students with low self-efficacy beliefs may exhibit lower motivation and avoid taking risks in biological drawing practical work. Building students' self-efficacy can be achieved through providing scaffolded support, constructive feedback, and opportunities for mastery experiences that allow students to develop and demonstrate their drawing skills.

Task value, including both intrinsic and extrinsic values, influences students' motivation in biological drawing. Intrinsic task value refers to the enjoyment, interest, and personal relevance students attach to practical tasks. Extrinsic task value encompasses the perceived instrumental value, such as the utility of biological drawing for future careers or academic success. Emphasizing the value of biological drawing by connecting it to real-world applications, career opportunities, and its relevance to students' lives can enhance their motivation and engagement.

The learning environment, including classroom climate, teacher-student interactions, and the availability of resources, can significantly impact student's motivation in biological drawing. A positive and supportive classroom climate that foster collaboration, encourages risk-taking, and values students' contributions promote motivation and engagement (Darling-Hammond & Cook-Harvey, 2018).

Effective teacher-student interactions that provide guidance, feedback, and constructive support can enhance students' motivation and self-efficacy. Access to appropriate resources, materials, and equipment is also crucial to create a conducive learning environment for biological drawing.

It is important to note that motivation is a dynamic construct that can vary among students and across different practical tasks. Some students may naturally be more motivated in biological drawing, while others may require additional support to develop and sustain their motivation. Different instructional strategies, such as problem-based learning, authentic investigations, and inquiry-based approaches, can be employed to enhance students' motivation by promoting active learning, autonomy, and meaningful engagement.

2.10 Factors Influencing Performance in Biological Drawing

This section explores various factors that can influence students' performance in biological drawing, such as students' prior experience, teacher's pedagogical approaches, availability of resources and equipment, and classroom environment. The performance of students in biological drawing is influenced by a range of factors that can shape their learning experiences and outcomes (Cosgrove *et al.*, 2014).

Understanding these factors is crucial for identifying areas where students may encounter challenges and implementing effective strategies to support their performance. This section explores various factors that can influence students' performance in biological drawing, including their prior experience, teacher's pedagogical approaches, availability of resources and equipment, and the classroom environment.

One significant factor that can impact students' performance in biological drawing is their prior experience and exposure to hands-on drawing activities. Students who have had more opportunities to engage in practical work, either through school activities, extracurricular programs, or personal interests, tend to have a better foundation in scientific inquiry and experimental techniques (Prokop & Fančovičová, 2017). Their prior experience may contribute to greater confidence, familiarity with laboratory procedures, and the ability to troubleshoot problems effectively. On the other hand, students with limited exposure to biological drawing task and science practical work in general may face challenges in understanding experimental protocols, interpreting data, and applying scientific concepts to real-world scenarios (Dubinsky *et al.*, 2019). Therefore, it is essential to consider students' prior experience when designing biological drawing activities and provide appropriate support to bridge any gaps in their knowledge and drawing skills.

The pedagogical approaches employed by teachers also play a crucial role in influencing students' performance in biological drawing. Teachers who adopt student-centered and inquiry-based teaching methods tend to create an environment that encourages active engagement, critical thinking, and problem-solving skills. Such

approaches promote a deep understanding of biology concepts and the development of science process skills. Conversely, teacher-centered approaches that rely heavily on lectures and demonstrations may limit students' opportunities for active participation and exploration. Providing teachers with professional development opportunities and resources that enhance their capacity to deliver effective biology practical work experiences can positively impact students' performance (Keiler, 2018).

The availability and quality of resources and equipment in the classroom can significantly influence students' performance in biological drawing (Umar, Fugu, & Aliyu, 2018). Adequate laboratory facilities, well-maintained equipment, and a sufficient supply of materials are essential for students to conduct experiments and carry out investigations effectively. Limited resources or outdated equipment can restrict students' opportunities for hands-on learning and hinder their ability to gather accurate data. Access to appropriate resources not only enhances students' practical drawing skills but also fosters their enthusiasm for biology and promotes a positive learning experience.

Additionally, the classroom environment, including the interactions between students and the overall atmosphere, can impact their performance in biological drawing (Cho & Baek, 2019). A supportive and collaborative classroom environment encourages students to share ideas, collaborate on projects, and learn from each other's experiences. Peer-to-peer interactions and discussions during drawing activities can stimulate critical thinking, deepen understanding, and improve overall performance. Conversely, a competitive or hostile environment may discourage students from actively participating or seeking help when needed, negatively affecting their performance.

Creating a positive and inclusive classroom climate is vital for maximizing students' potential in biological drawing.

Furthermore, the influence of factors such as cultural background and gender should also be considered. Students from diverse cultural backgrounds may bring unique perspectives and approaches to biological drawing practical activities, enriching the learning experience for all students. Additionally, research suggests that gender-related factors can influence students' performance in biological drawing. For instance, studies have found differences in confidence levels, self-efficacy, and participation rates between male and female students in science-related activities (Cho & Baek, 2019). Addressing potential gender disparities and providing equal opportunities and support for all students is essential for fostering an inclusive and equitable learning environment.

To optimize students' performance in biological drawing, it is important to provide opportunities for students to develop prior experience and exposure to hands-on activities. This can be achieved through structured laboratory sessions to promote scientific inquiry and experimentation. By actively participating in biological drawing from an early stage, students can develop the necessary skills and confidence to navigate complex drawing task.

Teachers play a crucial role in shaping students' experiences and outcomes in biological drawing (Ahmed & Mikail, 2022). By adopting student-centered pedagogical approaches, teachers can foster an environment that promotes active engagement and critical thinking. Encouraging students to ask questions, design experiments, and reflect

on their findings stimulates deeper learning and enhances their performance in biological drawing. Additionally, providing clear instructions, guidance, and timely feedback can help students navigate drawing tasks effectively and improve their overall performance.

The availability and quality of resources and equipment are key determinants of students' success in biological drawing (Chala, 2019). Schools should prioritize the provision and maintenance of well-equipped laboratories, ensuring that students have access to necessary apparatus, specimen, and safety measures. Moreover, regular monitoring and updating of resources can help keep pace with advancements in scientific techniques and ensure that students are exposed to the most relevant and up-to-date tools and technologies.

The classroom environment plays a vital role in shaping students' experiences and performance in biological drawing. Creating a positive and inclusive atmosphere where students feel safe to explore, take risks, and collaborate fosters a conducive learning environment (Benjamin & Kline, 2019). Encouraging teamwork, communication, and peer-to-peer learning can enhance students' understanding of biological concepts and improve their drawing skills. Teachers can promote a supportive classroom climate by valuing and respecting students' contributions, addressing any biases or stereotypes, and encouraging equal participation and opportunities for all (Barrett, Huber, & Reynolds, 2014).

Lastly, it is crucial to recognize and address any potential disparities in performance related to cultural background or gender. Embracing and celebrating diversity in the

classroom can enhance the richness of students' experiences in biological drawing. By providing culturally relevant examples, incorporating diverse perspectives, and acknowledging the unique contributions of each student, educators can create an inclusive learning environment that promotes equitable opportunities for all. Similarly, addressing gender-related disparities in performance requires implementing strategies that empower and support female students, promoting their confidence and interest in biological drawing.

Students' performance in biological drawing is influenced by various factors, including prior experience, teacher's pedagogical approaches, resources and equipment availability, and the classroom environment (Curelaru, Curelaru, & Cristea, 2022). By recognizing and addressing these factors, educators can create an optimal learning environment that enhances students' engagement, learning outcomes, and overall success in biological drawing. By providing opportunities for hands-on experiences, adopting student-centered pedagogies, ensuring access to quality resources, fostering a positive classroom climate, and promoting inclusivity, educators can maximize students' potential and facilitate meaningful and effective learning experiences in biological drawing.

While the previous section discussed several key factors that can influence students' performance in biological drawing, it is important to delve deeper into other influential factors that can impact their outcomes. This section explores additional factors, including students' motivation and interest, assessment methods, teacher-student interactions, and curriculum design.

Motivation and interest play a significant role in students' engagement and performance in biology biological. When students are intrinsically motivated and have a genuine interest in the subject matter, they are more likely to invest time and effort in understanding and applying biological concepts in practical settings (Wlodkowski & Ginsberg, 2017). Teachers can foster motivation and interest by connecting practical work to real-life situations, highlighting its relevance, and promoting student autonomy and choice within the learning process. Providing opportunities for students to pursue their own research questions or design their experiments can ignite their curiosity and enhance their performance.

The assessment methods used in biological drawing can also influence students' performance. Traditional assessment methods that primarily focus on memorization and recall may not effectively capture students' understanding and application of drawing skills (McTighe & Willis, 2019). Incorporating performance-based assessments, such as practical exams, laboratory reports, or research projects, can provide a more comprehensive evaluation of students' abilities. These assessments should align with the intended learning outcomes and emphasize critical thinking, problem-solving, and scientific inquiry skills. By utilizing appropriate assessment methods, teachers can provide constructive feedback and identify areas where students may need additional support.

Teacher-student interactions and communication are crucial for facilitating effective learning experiences in biological drawing. Establishing a supportive and respectful teacher-student relationship can create a conducive learning environment where students feel comfortable seeking guidance, asking questions, and sharing their ideas.

Teachers who provide clear instructions, offer timely feedback, and engage in dialogue with students can enhance their understanding and performance in practical work (Nicol & Macfarlane-Dick, 2006). Encouraging open communication and active participation can foster a sense of ownership and responsibility among students, leading to improved performance outcomes.

The design and implementation of the biology curriculum also have a significant impact on students' performance in biological drawing. A well-structured and coherent curriculum that integrates practical work and drawing skills throughout the learning process allows students to develop a deep understanding of biological concepts and their practical applications. Providing a progressive sequence of activities that build upon prior knowledge and skills enables students to gradually develop proficiency in experimental techniques and data analysis. A curriculum that balances theoretical knowledge with drawing experiences promotes meaningful learning and enhances students' performance (Bailey, Jaggars & Jenkins, 2015).

Furthermore, the availability of external support systems, such as professional development opportunities for teachers and collaboration with external organizations or experts, can positively influence students' performance in biological drawing (Voogt *et al.*, 2015). Teachers who have access to ongoing training and resources related to biological drawing can enhance their instructional strategies and stay updated with the latest advancements in the field. Collaboration with external experts or partnerships with research institutions can provide students with exposure to real-world scientific practices and inspire them to excel in their biological drawing.

2.11 The effect of gender on drawing skills, interest and achievement in biology

Gender imbalance is noticeable in almost every facet of life. Gender issues have remained inconclusive from the results of various studies. The result from the study of Yusuf and Afolabi (2010) revealed no gender influence on the performance of students taught biology using Computer Assisted Instruction (CAI). On the contrary, male students achieved better in biology than the female students when taught using Jigsaw method (Odagboyi, 2015). The study of Olasheinde and Olatoye (2014) indicated no significant difference in the performance of male and female students in science. Furthermore, there was no effect of gender on the performance of students taught integrated science by male and female pre service teachers (Afunwape & Oludipe, 2008). Whereas, Jordan (2013) claimed that male beginning teachers' content knowledge were higher than that of the female teachers which made the students taught by male teachers to perform better than the students taught by female teachers.

According to Adewale, Nzewuihe and Ogunshola (2016) the same curriculum is used to teach the students who take senior secondary school certificate examination yet their performances differ from school to school as well as among those who passed, the grades differ. Grades also differ among genders according them. The female gender has better academic performance in biology as all girls-only schools did better in the senior secondary school certificate examination between year 2009 and 2013 than the mixed schools. The findings of Adewale, Nzewuihe and Ogunshola (2016) reveal that in practical courses, the male gender achieves better than the female gender although slightly that it is not even statistically significant. Wekesa (2013) is of the opinion that gender has no effect on the level of interest of students but gender had effect on the area

that the students have interest in. He further stated that the male gender was less interested in environmental protection, human biology, and health issues but had more interest in ecology and evolution as well as cell biology and gene.

Several studies have investigated the potential gender differences in students' acquisition of drawing skills in biology. It has been suggested that male students may exhibit higher confidence and familiarity with laboratory procedures, which can contribute to their perceived advantage in practical work (El-Emadi, Said, & Friesen, 2019). However, other studies have reported no significant gender disparities in the acquisition of drawing skills, suggesting that gender may not be a determining factor in skill development (Powell & Ansic, 1997).

Participation rates in biology practical work have also been examined in relation to gender. Some research has found that female students may be less likely to actively engage in practical tasks compared to their male counterparts (Doucette, Clark, & Singh, 2020). Factors such as social norms, stereotypical expectations, and perceived gender roles may contribute to this discrepancy. However, it is important to note that these findings are not consistent across all studies, and there are instances where female students have demonstrated equal or higher levels of participation in biological drawing.

When it comes to performance outcomes, the literature presents mixed findings regarding gender differences. Some studies have reported that male students tend to achieve higher scores in biological drawing assessments compared to female students. This could be attributed to various factors, including differences in self-confidence,

test-taking strategies, and attitudes towards science. However, other studies have found no significant differences in performance between genders, suggesting that individual variations and contextual factors may play a more significant role than gender itself. One possible explanation for the observed gender differences in performance could be the influence of self-efficacy beliefs. Self-efficacy refers to an individual's belief in their ability to successfully perform a specific task. Research has shown that gender differences in self-efficacy beliefs can impact performance outcomes in various academic domains, including science. Female students, in particular, may exhibit lower self-efficacy beliefs in science and practical work due to societal stereotypes and implicit biases. These lower self-efficacy beliefs can lead to reduced motivation, self-perception, and ultimately, performance.

Educational interventions and instructional approaches can play a vital role in addressing gender disparities in biological drawing (Reilly, Neumann, & Andrews, 2017). Providing opportunities for all students to actively participate in hands-on activities, fostering a supportive classroom climate, and promoting equitable access to resources and laboratory equipment are important steps towards promoting gender equity. Additionally, incorporating diverse role models, highlighting the contributions of female scientists, and challenging gender stereotypes can help to inspire and empower female students in their pursuit of science and biological drawing.

It is important to acknowledge that gender differences in biological drawing performance are not solely determined by biological factors. Sociocultural and contextual influences, such as the learning environment, teacher expectations, and societal attitudes towards gender roles, also contribute to these disparities (Wang &

Degol, 2013). By recognizing and challenging these factors, educators and policymakers can work towards creating a more inclusive and supportive environment that encourages all students, regardless of gender, to excel in biological drawing.

Gender differences in biological drawing performance have been the subject of investigation in educational research. While some studies have reported gender disparities in drawing skills acquisition, participation rates, and performance outcomes, others have found no significant differences. Factors such as self-efficacy beliefs, social norms, and contextual influences contribute to these differences.

Promoting gender equity in biology practical work requires fostering a supportive and inclusive learning environment, challenging stereotypes, and providing equal opportunities for all students. By addressing these factors, educators can create an environment that empowers all students to succeed in biological drawing, regardless of their gender. Further research is needed to deepen our understanding of the complex interactions between gender and performance outcomes and to identify effective strategies for promoting gender equity in biology education.

Several studies have explored the underlying factors that may contribute to the observed gender differences in biological drawing performance. One potential explanation is the influence of societal stereotypes and biases that shape students' beliefs and attitudes towards science. Research has indicated that gendered expectations regarding aptitude and interest in science can impact students' self-perception and motivation to engage in biological drawing. Girls, in particular, may face societal pressures that discourage their

involvement in science-related activities, leading to lower participation rates and potentially influencing their performance outcomes (Alam, 2019).

Additionally, research has highlighted the role of classroom dynamics and teacher expectations in perpetuating or mitigating gender differences in biological drawing performance. Teachers' biases and expectations may unintentionally influence their interactions with students, which can impact students' confidence, engagement, and performance. Studies have shown that when teachers provide equal opportunities, support, and encouragement to all students, irrespective of gender, the gender disparities in performance diminish. Therefore, teacher training and professional development programs that address implicit biases and promote gender-inclusive practices are crucial for fostering equitable learning environments.

Furthermore, individual differences in learning styles and preferences can contribute to the observed gender differences in biological drawing performance. It is essential to recognize that students have diverse ways of acquiring and processing information, and these differences may not be solely attributable to gender. Tailoring instructional approaches that accommodate various learning styles and provide multiple entry points to engage students can help bridge the gender gap in performance outcomes. For instance, incorporating visual aids, hands-on activities, and collaborative learning opportunities can enhance students' understanding and performance in biological drawing.

While the focus of this section is on gender differences, it is important to emphasize that gender is a complex construct influenced by various intersecting factors such as

race, ethnicity, socioeconomic status, and cultural context. Intersectionality plays a crucial role in shaping students' experiences and outcomes in biological drawing. It is important to consider these intersecting identities and their potential impact on students' performance to develop inclusive strategies that address the needs of all students. Research examining gender differences in biological drawing performance highlights the existence of disparities, although the extent and nature of these differences may vary across studies. The influence of societal stereotypes, biases, teacher expectations, and individual differences in learning styles contribute to the observed gender disparities. Promoting gender equity in biological drawing requires addressing these factors through teacher training, fostering inclusive classroom environments, and providing equal opportunities for all students to engage in drawing activities. By challenging stereotypes, biases, and promoting inclusive practices, educators can create learning environments that empower all students to excel in biological drawing. Further research is needed to explore effective interventions and strategies that can bridge the gender gap and promote gender equity in biology education.

2.12 School Type and Academic Achievement in Biology

Before 1990 in Ghana, the categorization of senior high schools has been single-sex schools and co-educational institution or urban and rural schools. Recently, however, there is a new categorization of schools in terms of resource and facilities that are available in schools. Ampiah (2004) reported that because of significant inequities in the facilities and equipment in the science laboratory and depending on the financial standing of the senior high school, they are being classified into well-endowed and less-endowed schools. Lately, there has been a slight modification in the well-endowed and less-endowed school to encompass the third status of endowed senior high schools.

According to Ghana Education Service (2015), Senior High Schools (SHSs) in Ghana have been grouped into three options on the basis of endowment of resources and equipment as well as their performance in final examination conducted by WAEC. Consequently, we have option A. SHS which are well-endowed, option B SHS which are averagely-endowed and option C SHS which are less-endowed. These are the categorization of SHS in Ghana into A, B and C. Most of the well-endowed, averagely-endowed SHS are located in the urban areas and most of the less-endowed SHSs are located in the rural areas Dah (2020).

The Category A, B, C, D of Senior High Schools in Ghana are used by the Ghana Education Service to place students moving from the Junior High Schools (JHS) into Senior High Schools (SHS), Senior High Technical Schools (SHSTS) and Technical and Vocational Institutes (TVIs). This categorization is based on school facilities including well equipped science laboratory, population and academic performance. The classification of schools into grades A, B, C, and D in Ghana is typically based on their performance and infrastructure.

The Ghana Education Service (GES) uses various criteria to evaluate schools and assign them grades. These criteria may include academic performance in examinations, teacher qualifications, facilities, and other factors. Here's a general overview of how the school grades might impact academic performance in Ghana:

1. Grade A Schools:

- These are often considered top-performing schools with good infrastructure and well-qualified teachers.

- Students in Grade A schools may have access to better resources, facilities, and a more conducive learning environment.
- There might be higher expectations for academic excellence, and the school may attract motivated students.

2. **Grade B Schools:**

- Grade B schools may still be considered above average in terms of academic performance and facilities.
- Students in these schools may have reasonably good access to resources, but there might be some limitations compared to Grade A schools.

3. **Grade C Schools:**

- Grade C schools may face challenges in terms of infrastructure or teacher qualifications, impacting the overall learning experience.
- Students in Grade C schools might have fewer resources and face more obstacles to academic success.

4. **Grade D Schools:**

- Grade D schools are likely to have significant challenges, including poor infrastructure and lower academic performance.
- Students in Grade D schools may face more difficulties in achieving academic success due to limited resources and support.

It's important to note that while the school grading system can provide a general indication of the educational environment, individual student performance depends on various factors, including personal motivation, family support, and the effectiveness of teachers. Additionally, the grading system itself can evolve, and schools may improve or decline over time.

Efforts are often made by educational authorities to address disparities among schools, such as providing additional resources to lower-performing schools or implementing policies to improve overall education quality across the board. Educational research and policy interventions can also play a role in shaping the academic landscape in Ghana. Senior High schools, irrespective of the school type are expected to function in compliance with the achievement of the national education objectives. To this end, students are expected to perform brilliantly in the final examination as this determines the quality of output of senior high schools. This is one of the parameters used to measure the effectiveness of a school system. The better the performance of the students, the more effective the system is assumed to be (Philius &Wanjobi, 2011). In another related study, Cynthia and Megan (2008) confirmed a strong and positive relationship between quality of school facilities and student achievement in English and Mathematics.

In Ghana, it is the general opinion of people that grade A schools are better in terms of the availability of human and physical facilities and consequently students' performance than grade B, C and D schools and in that order. This situation has made many parents to enroll their children in schools that are classified as grade A. Facilities are of everything used directly or indirectly for the benefit of education. Facilities could also be explained as the entire school building such as blocks of classrooms, staffrooms, laboratories, workshops, libraries, laboratory equipment, consumables, audio-visual aids, electricity, water, chairs, tables, stationeries, playground, storage spaces and others which school has. It has always been realized that facilities are very important in the development and improvement of education in Ghana. A school without facilities, either grade A, B, C or D, may not be able to achieve the stated goals and objectives of

the system. When facilities are available and skillfully utilized, they influence learning and making it more meaningful. Facilities in education are very vital because they aid teaching and learning.

Bandele (2003) noted that the importance of physical facilities cannot be relegated. Facilities like modern laboratories, libraries and classrooms are to be put in place in all our schools. Adesola (2005) found out that the level of available resources is indeed a plus to the teachers and goes to show the level of ingenuity and commitment of the teachers toward effective delivery of lesson. There is the need for renovation of old buildings, chairs, desks, cabinets and acquisition of modern classrooms as earlier recommended by Alimi (2007). Akinfolarin (2008) identified facilities as a major factor contributing to academic performance in the school's system. These include classroom furniture, recreational equipment among others. Different studies conducted by Ayodele (2000) and Vandiver (2011), showed that a positive relationship exists between availability of facilities and student academic performances. Research findings on the influences of facilities in private and public secondary schools on students' academic performance are controversial. Keeves (1978) found out that the type of school, classified as public or private did not make any difference on students' academic performance. However, Ajayi (2006), found out that school type makes a difference in student academic performance. In addition, Philius and Wanjobi (2011) reiterated that the type of schools, (single sex or mixed, private or public) has effect on the academic performance of students in Mathematics. Therefore, this study wants to find out whether a relationship exists in types of school whether grade B or C in the study area also has influence on academic achievement in biological drawing.

2.13 Impact of Laboratory Skills and practical experience on Students

Performance in Biology

The inclusion of practical work as a method of learning science, particularly biology, is emphasized in Ghana's educational reform. The syllabus viewed practical work as an integral part of learning (Grasha, 1996). More so, since Biology is activity based, it is the responsibility of the teacher to ensure that there is adequate interaction between the parties involved. Biology practical enable both teacher and student to:

- i. Have a feel of the learning instruments.
- ii. Develop or formulate hypothesis.
- iii. Develop an investigative attitude towards a problem.
- iv. Developing manipulative skills for both parties.
- v. Emphasize biological information or the essential facts that are strictly relevant to the West African Examinations Council and the Senior High School syllabus.
- vi. Facilities stimulate and encourage self-tuition of the senior high school student.

According to WAEC Chief Examiners Report (2018), the observed weakness includes

- i. Inability to relate structure with function of specimens
- ii. Poor spelling of technical term and one-word answer e.g., anthropoda, atropoda, arthropodia instead of arthropoda and isecter instead of insecta
- iii. Starting taxonomic names with small letters
- iv. Breaking a single technical word into two words e.g., house fly for housefly
- v. Inability to title diagram correctly
- vi. Poor diagram of a specimen (specimen k) pride of Barbados flower
- vii. Not including the magnification of the diagram
- viii. Using unruled or crossing guidelines in labeling diagrams;

- ix. Using plural instead of singular for a single guideline
- x. Using guidelines that do not match the structure;
- xi. Making diagrams without the correct specifications;
- xii. Labeling with guideline that are not ruled;
- xiii. Drawing the wrong specimen and drawing off-hand making their have little or no link with the question asked
- xiv. Inability to mention specific habitats of organisms
- xv. Inability to tabulate answers on differences
- xvi. Inability to compare two specimens correctly. Pride of Barbados flower and elephant grass (specimen K and L respectively)

Other common error is Overlapping lines.

All these common errors can be linked directly to the lack of adequate laboratory experience. Most schools give their students access to the laboratories when it is time to prepare for external examinations only. The laboratories in most schools lie fallow as the reason for building them in the first instance was to get accreditation from the government. Enebechi (2009) stated that some biology teachers fail to conduct biology practical along-side every topic treated during lessons, until a few days to examination when they will use WAEC specimens to conduct practical for their students. Laboratory activities are important in developing biological skills. Laboratory activities also provide opportunities to collect and analyze data and apply mathematical knowledge to support and illustrate concepts, facts and principles (Garnett, 2005; Lunetta, 2008). Laboratory practical works provide a way not only for developing varieties of different practical skills but also developing favorable attitudes, interest, pleasure, enthusiasm, imitation, imagination and cooperation among students (Nworgu, 2009).

Bajon (2015) found out that, students taught biology using group laboratory activity performed better than their counterparts, taught biology using individual laboratory activity. He also stated, students who work cooperatively perform better than their counterparts who work individually. When students work in group to generate their own question, analyze and discuss their findings and finally organize their thoughts, they seem to understand their own information better than the ones the teachers introduced to them or the ones that they generate individually. Schools grouping students is the common practice of class management when conducting practical lessons in large classes (Edson, Mwangi, Lwazi & Sibanda, 2017).

2.14 Students' Attitude towards Practical Work

The Chief Examiners' Report WAEC (2009) complained of students' inability to describe experiments and experimental data. It also complained about students' poor drawings and incorrect spelling of biological terms. Another report, WAEC (2007) indicated just about the same thing with regards to biological diagrams. This performance of students in practical work can be attributed to a basic problem in the teaching of Biology. It is because previous studies represented that there is little to show that practical work is effective in helping students in learning science knowledge than other methods of learning science (Watson, 1989). This situation arises as a matter of most students seeing practical work as boring, time consuming and non-beneficial. It is therefore imperative, that practical lessons be so designed as to enable students to develop collaborative skills. After studying students cognitive and mastering of skills, Asabre- Ameyaw and Haruna, (2007) indicated that, there was no substitute for practical work, the same authors are of the view that the theoretical and practical components of teaching biology cannot be separated. Again, Asabre- Ameyaw and

Haruna (2007) emphasized that most practical work in school is not taken. The reason given was that there is no clearly known policy that is followed by schools with regards to practical work. It is widely recognized and acknowledged that all sciences have empirical basis and they involve practical pursuits and activities. Practical skills and abilities are those that form an integral process in science through which the investigator obtained first-hand experience of some scientific phenomenon or relationship (Kemps, 2000).

The responsibility for operating the system of practical assessment for Senior High School (S.H.S) lies with the teachers in the school who carry it out internally with external moderation. Practical assessments are not easy and doubt, does persist about its credibility and about carrying it out efficiently under natural circumstance of science teaching. A worthwhile aim of practical assessment is to be ensured of purposeful practical work (Natalie & Johnson, 1989). Where facilities and resources are available, a qualified and motivated science teacher will deploy learner-centered approaches to teaching and learning. Such an approach emphasizes practical activities and students will be involved in practical hands-on-activities. This approach stimulates curiosity, imagination and critical thinking. It keeps the lessons exciting and captivating to the young scientists (Asare, 2010). The WAEC senior high school biology syllabus emphasizes the acquisition of scientific skills (e.g., accurate observation, measurement and recording), laboratory skills as well as scientific attitudes (e.g., Concern for accuracy, objectivity, integrity, initiative etc.). It is therefore expected that students would go through practical work in preparation for the final WAEC biology practical examinations. However, a variety of specific students' weaknesses in the practical examinations reported by the Chief Examiners cast serious doubts on senior high school

students' involvement in practical activities in the schools. This gives the impression that students are either not taken through practical activities or do not take them seriously (Owiredu, 2012). Some of the persistent weaknesses identified over the years (2000-2020) by the Chief Examiners for biology are as follows: Biology:

- i. Technical terms were wrongly spelt and also failure to adhere to the convention of writing scientific names.
- ii. Candidates were incapable of critical analysis and interpretation of biological data.
- iii. Candidates were not having adequate practical work as shown by the answers provided.
- iv. Most candidates could not draw diagrams from observation of specimen; thus, the standards for drawing were very poor.
- iv. Descriptions of graphs drawn were inaccurate and explanation of the data deduced from the graphs was poor.
- v. Some candidates presented very poor and inaccurate genetic diagrams.
- vii. Difficulty in relating observable features to their functions.

The importance of practical work cannot be overemphasized. Learners' involvement in practical activities in the laboratories assists them to better understand scientific processes. The issue of the importance of a laboratory in science teaching, therefore, cannot be overemphasized. In a laboratory and with the relevant material and equipment, learners are provided with the chance to actively learn science, which is by nature investigative (Tobin, 1990). The importance of learners' active involvement in science learned is further emphasized by Osborne and Collins (2000) who argued that

learners construct meaningful scientific knowledge and investigative processes by being actively involved in science knowledge construction.

Similarly, Orji (2006) noted that the availability and proper use of relevant materials such as library materials and science laboratory equipment have a positive influence on learner performance and ultimate attainment.

2.15 The Roles of Teachers towards Students Interest and Biological Drawing Skill

To be a teacher means “to be educated, in the sense of a broad-band form of disciplined knowledge; specialized, in the sense of in-depth knowledge in a given area; professionally trained, in the sense of internalization of knowledge, skills, attitudes and values needed for promoting learning, professionally competent, in the sense of applying his/her skills to promote learning; and a lover of learning in such a way that his/her personality inspires the learner” (Nwaboku, 2006)

Teachers have a great role to play in building students’ interest in biology by using appropriate teaching methods. Methods that involve concrete experience in the laboratory or in the field ease the teachers’ works as construction of scientific ideas becomes easier for the students. Involving students in observation of specimens and drilling them to build their drawing skills. The junior secondary school teachers as well as the senior secondary school teachers have great roles to play in developing students’ interest in biology and ensuring that the methods adopted to teach them facilities excellent performance in the subject. This is so because without having at least a credit in the final junior secondary school examination, a student may be denied the opportunity to pursue his science career. A student, who scales through, may also be

denied further opportunities of studying a science-oriented course in the university if he fails to meet up with the academic standard required hence denying individuals with career aspirations in science, their career. For without degree in a science course, no one can have a science career.

The inquiry centered approach is the most appropriate method a teacher can use to develop students in biology. Inquiry is the basis of every scientific discovery hence students who are exposed to biology through the inquiry method are in the process building scientific attitude that is necessary for their academic excellence in the science field. National Research Council (1996) pointed out that students who use inquiry to learn science actively engage in activities and thinking processes as scientists. Sheldrake, Mujtaba, and Reiss (2017) identified inquiry method to be identified when hands-on/practical activities and student-led investigation been done also revealed that it does build higher interest in students.

Inquiry is the method through which human get new knowledge, it is a result of natural curiosity The role of the teacher is to use instructions and the various means of assessment to build students inquisitiveness hence their thinking skills as well as their scientific attitudes which would be useful for their everyday life and their scientific career.

2.16 Summary of the Review

From the literature drawings do not only allow you to record an image of the specimen observed, but more importantly, they help you to remember the specimen as well as the important features of the specimen. Drawing a specimen requires you to pay attention

to detail so that you can re-create it on the sheet. While doing this, your brain is recording these same features in such a way that you can recall them if necessary (for example in an exam). Biological drawing actually trains and test your power of observation. Having a strong power of observation is one characteristic that a future scientist must have. Biological drawings could be used to diagnose the quality of students' understanding about a concept. Drawings also break monotony in teaching, prevents teachers' centeredness, show relationships among different complex concepts in a simpler form, reveal students' previous knowledge about a specimen among others. One of the main objectives of teaching is to make students acquire laboratory skills, field skills, and scientific attitudes. This indicates that teaching biology requires both practical and theoretical approaches. From literature, if students are to learn science meaningfully, science teachers must be motivated and adopt student-centered approaches by providing hands-on activities for students in teaching and learning process so that they can construct their knowledge actively.

According to literature the availability and quality of resources and equipment are key determinants of students' success in biological drawing. Schools should prioritize the provision and maintenance of well-equipped laboratories, ensuring that students have access to necessary apparatus, specimen, and safety measures. Moreover, regular monitoring and updating of resources can help keep pace with advancements in scientific techniques and ensure that students are exposed to the most relevant and up-to-date tools and technologies in all category of schools.

Male and Female can develop their potential to the fullest when given equal opportunity in science classroom. According to literature it is clear that gender is independent of

students' performance in science and if male and female are provided equal opportunities, support, and encouragement to all students, irrespective of gender, the gender disparities in performance diminish and therefore student will excel in biological drawing. Therefore, teacher training and professional development programs that address implicit biases and promote gender-inclusive practices are crucial for fostering equitable learning environments.

CHAPTER THREE

METHODOLOGY

3.1 Overview

This chapter describes how the study was conducted. It is organized into the following sections: research design, population of the study, sample and sampling procedure, the instrument for data collection, validity of the instrument, reliability of the instrument, administration of the instrument or data collection procedure and methods of data analysis.

3.2 Research Design

The mixed methods design was used for the study. A mixed-methods design offers a number of benefits to approaching complex research issues, as it integrates philosophical frameworks of both post-positivism and interpretivism (Fetters, 2016) interweaving qualitative and quantitative data in such a way that research issues are meaningfully explained. It also offers a logical ground, methodological flexibility and an in-depth understanding of smaller cases (Maxwell, 2016). In other words, the use of mixed-methods enables researchers to answer research questions with sufficient depth and breadth (Enosh, Tzafir, & Stolovy, 2014) and helps generalize findings and implications of the researched issues to the whole population. A mixed-methods approach, is comprehensive research methodology that integrates the collection, analysis, and synthesis of both quantitative (experiments, surveys) and qualitative (focus groups, interviews) data. The mixed-methods approach aligns with the pragmatism paradigm, which posits that knowledge is constructed through our experiences in the world and social environment (Schoonenboom, 2019). This

perspective diverges from that of positivists and interpretivists, who respectively assert that knowledge is objective and external to the researcher or primarily constructed. The pragmatic worldview serves as a liberal alternative that bridges the gap between the two contrasting paradigms of quantitative and qualitative research. By embracing the pragmatic worldview, this study acknowledges the importance of both objective measurements and subjective interpretations in gaining a comprehensive understanding of the research topic.

A mixed-methods design, therefore, offers the best chance of answering research questions by combining two sets of strengths while compensating at the same time for the weaknesses of each method (Johnson & Onwuegbuzie, 2004). Consequently, "mixed-method research designs are becoming increasingly relevant to addressing impact research questions" (Saville, 2012).

The explanatory sequential mixed methods design was specifically used for the study. The explanatory sequential design, which involves collecting and analyzing quantitative data and then following up with qualitative data collection and analysis to explain the quantitative results. This sequential process enables the qualitative data to provide additional insights and explanations to complement the quantitative findings (Creswell, Klassen, Plano Clark, & Smith, 2011; Dawadi, Shrestha, & Giri, 2021). The explanatory sequential mixed methods design was adopted in this study because it provide an avenue to merge the qualitative and quantitative results of the study and thus provide a comprehensive analysis of the research problem for a more holistic understanding than employing either quantitative or qualitative approach alone (Creswell, 2014; Pone & Pagan-Maldonado, 2015).

By employing an explanatory sequential mixed-methods approach, this research aims to benefit from the strengths of both quantitative and qualitative approaches. The initial quantitative data collection and analysis provided a broad understanding of the research topic, allowing for generalizations and statistical inferences. Subsequently, the qualitative data collection and analysis delve deeper into the participants' perspectives and experiences, enriching the understanding of the phenomenon under investigation. A survey or questionnaire that includes quantitative items related to biological drawing knowledge to assess students' ability to accurately represent biological structures, label parts, and demonstrate understanding of scientific concepts related to drawing. Based on the quantitative findings, a subgroup of participants was selected for the qualitative phase, with varying levels of drawing knowledge.

Focused group interview was conducted to gather qualitative data on students' experiences, attitudes, and beliefs about biological drawing. These data helped to explain the quantitative results obtained in the previous phase. Consequently, the mixed method design was selected because the research problem could not be address holistically from the unique perspective of only a quantitative or qualitative study. There was, therefore the need to generate quantitative and qualitative data towards a clear and deep understanding of the research problem being addressed in order for the problem to be solved in its entirety.

3.3 Population

The population for the research consists of all second year SHS elective biology students in Senior High Schools in Sekyere South District of Ashanti region of Ghana. Second year biology students formed the population for the research, since, they were

not focusing on writing their final examination. An accessible population of about 150 students from a target population of about 300 students were used for the research. The five SHS selected for this research has been categorized by Ghana Education Service (2015) into three options on the basis of endowment of resources and equipment. Consequently, we have options in the district, i.e., Grade C, which is less-endowed and Grade B, which is averagely-endowed in terms of resources and facilities. The five schools which were sampled for this research comprises of three averagely-endowed and two less-endowed schools. (Source: Sekyere South Education Directorate, 2015).

3.4 Sampling Procedure

The participants in this research were all Ghanaian second-year public senior high school science students in the Sekyere South District of Ashanti Region. The second-year public Senior High School science students were used because the concept on biological drawing is found in Year 1, Section 1 and Unit 6 of the biology syllabus and students were required to have learnt the guidelines on biological drawing and also draw a lot of biological specimens and in addition the second-year were not focusing on writing their final examination.

There are five public senior high schools in the Sekyere South district which offer elective biology. All the five public schools are coeducational (CE) schools and as such they were conveniently selected to be part of the study. Three out of the five schools are category B schools (according to GES classification) and the remaining two are category C schools. These categories are assigned depending on the available facilities (GES, 2009), and not according to academic performance. The sample size comprised 150 SHS 2 elective Biology students from five public SHSs in the Sekyere South

district. These students were made up of 75 males and 75 females in order to cater for gender equality in the sample size. Three schools were classified as category B schools and using computer generated numbers, two were randomly selected to participate in the part of the study which sought to find out student knowledge in biological drawing based on school type. Also, 60 respondents each were sampled from the category B and C schools for the part of the study based on school type. This meant that equal proportions of the number of students were used from all category of schools for the study. In addition, Biology teachers in SHS 2 in the sampled schools were purposively selected and thus five Biology teachers at SHS 2 in the selected schools responded to the research instruments.

Stratified Random Sampling technique was used in selecting students from the five coeducational SHSs. In selecting the students, two strata of boys and girls were formed. The total list of boys offering Biology at SHS 2 in each of the five coeducational schools were obtained from their teachers. Likewise, the total list of girls pursuing Biology in each of the SHSs was also obtained. Computer generated random numbers were used to select 15 students from each stratum. Computer generated random numbers were used because it gave each student equal opportunity of being part in the sample size. The essence of the stratification was to increase precision, representativeness and to ensure gender equality in the sample.

The participants in the study did not use their names but were given identification numbers for the purpose of easy identification and to ensure anonymity of the participants. The three category B schools were coded as D, E, and F while the two category C schools were coded as G and H. Every male students was given Y and every

female Student was given X and hence school D which is a category B school, the respondents were identified as DY₁ to DY₁₅ for males and DX₁ to DX₁₅ for females, in school E, the respondents were identified as EY₁ to EY₁₅ for males and EX₁ to EX₁₅ for females, school F, the respondents were identified as FY₁ to FY₁₅ for males and FX₁ to FX₁₅ for females, in school G and H which are category C schools, the respondents were identified as GY₁ to GY₁₅ for males and GX₁ to GX₁₅ for females, and lastly in school H, the respondents were identified as HY₁ to HY₁₅ for males and the females were labelled as HX₁ to HX₁₅.

3.5 Ethical Consideration

Before data collection the researcher met the students and their biology teachers and highlighted the purpose of the research and assured them of anonymity of their response and confidentiality of the data that would be gathered from them. It was further explained to the participants' that their personal details would be kept private and anonymous throughout and after the experiment.

3.6 Instrument for Data Collection

The research instrument for this study is Students' Biological Drawings Achievement Test (BDAT) drawn from validated West Africa Senior High School Certificate Examinations on biology. The concept on biological drawing is found in Year 1, Section1 and Unit 6 of the biology syllabus and students were required to have learnt the guidelines on biological drawing and also draw a lot of biological specimens. The instrument was used to collect data in two sections. Section "A" requested for biographical information of students such as; Students' gender. Section "B" was designed to have three questions. Part one; requires the labeling of an already drawn

specimen, (human endocrine system) and part 2 of section B is real practical where students were provided with a longitudinal section of a kidney and transverse section of an orange fruit to draw and label it.

The interview guide for the teachers and students were developed by the researcher as well. The students and teachers were interviewed because it enabled the researcher to gather primary data with respect to how often Biology practical lesson were organized and the challenges that are associated with the organization of Biology practical activities for the student to acquire biological drawing skills.

The instrument was given both face and content validity through experts in biology education at the Department of Biology and Integrated Science Education, AAMUSTED Mampong for their perusal and comments.

3.7 Validity of the Instrument

The instruments were subjected to face and content validation, the final items in the biology achievement test as well as the questionnaire were given to my supervisor for correction and final editing to ensure error-free questions. He checked the clarity of the items, suitability of the items and appropriateness of the language. A biology teacher in one of the schools was also given a copy for comments on any ambiguities, confusing terminologies or statements. Comments and inputs from the experts were used to fine-tune the test into the final one used for the actual study. The content validity was ascertained by using the biology syllabus as a form of table of specification to check whether the questions covered all aspects in biological drawings as stipulated. The construct validity was assumed since the questions were all culled from past WAEC

SSSCE biology papers. (All WAEC examination questions are supposed to have gone through various test of validity as a team of experts in assessment are employed to check all that.) For the interview schedule, only the face validity was considered. This was done by giving copies to experts of biology education in the Department of Biology and Integrated Science Education, AAMUSTED Mampong for their perusal and comments. They read through and gave their comments. After making the required changes, the schedule was used for the study.

3.8 Reliability of Instrument

The instruments were administered as a pilot test to a school (Boanim Senior High School) in the Sekyere South District which was not used for the actual study. A marking scheme was developed for scoring the items dichotomously, one part of the Biological Drawing Achievement Test (BDAT) was scored subjectively. The inter-rater reliability of the scores was determined. The inter-rater reliability coefficient was found to be 0.93. Kuder-Richardson (KR) 20 was used to determine the reliability of the other items which were scored objectively. The KR 20 value for the other part of the (BDAT) was found to be $r = 0.68$.

Overall, the pilot testing and subsequent reliability analysis of the test instruments aim to ensure that the data collected for the study is valid, reliable, and accurately represents the intended variables. These processes help enhance the quality and credibility of the research findings.

3.9 Data Collection Procedure

Before the collection of data, an introductory letter from the Department of Biology Education at AAMUSTED was given to the researcher. The letter explained the purpose of the study by the researcher and sought for assistance from the headmaster/headmistress of the institution. The introductory letter was first sent to Sekyere South District Education office to get the permission of the directorate to have access to the senior high schools under their jurisdiction. This enabled me get the list of SHSs offering biology program and their categorization into grade B and C schools. There were three grade B schools and two grade C schools.

After the selection of the sampled schools, the researcher first visited the schools with the introductory letter from the department together with a permission letter to make his intention known to the schools' authorities and to acquaint himself with the students and Biology teachers in the chosen schools. The researcher was given the permission to collect data with strict observation of COVID19 protocols, this was agreed upon after the headmasters/headmistress have consulted the Heads of Department for Biology program in the chosen schools.

The data collection procedure was carried out in two phases. In the first phase, Biological Drawings Achievement Test (BDAT) was administered to the participants. The students had 60 minutes to complete the test, and their responses was scored using a marking scheme developed by the researcher. The data obtained from the test was analyzed using descriptive statistics.

On the days that were set for the collection of data, the researcher went to the schools with the research instruments. He met the students and their biology teachers and highlighted the purpose of the research and assured them of anonymity of their response and confidentiality of the data that would be gathered from them. The Biological Drawing Achievement Test (BDAT) were given to the students to read through and seek any clarification on the tasks. For task A which was the labelling of the diagram of human endocrine system, task B was specimen of longitudinal section of kidney for students to draw and label the parts and lastly task C was specimen of transverse section of orange fruit for students to draw and label the parts.

At the end of the entire period which lasted for 60minutes the Biological Drawing Achievement Test were taken from the students to marked with WAEC standard marking scheme prepared by the researcher. The competency level of the Biological Drawing Achievement Test was rated using scoring rubrics which ranged from 0 to 5 points. A score of 5 points indicate excellent level of competence, 4 points indicate very good level of competence, 3 point showed good level of competence, and 2 points indicate a fair level of competence, 1 point showed a poor level of competence and 0 showed no acquisition of level of competence. This was analyzed with descriptive statistics such as mean and standard deviation and the result were presented in tables.

In the second phase of data collection, a semi-structured focused group interview was conducted to gather qualitative data on the students' experiences with the Biological Drawings Achievement Test (BDAT). A purposive sampling technique was used to select 25 students from the total sample of 150 participants and five teachers (one from each school). The interviews were conducted in a quiet and comfortable environment, and was audio-recorded with the participants' consent. The focus group interview lasted

for 30minutes in each school sampled for the interview. The teachers and students were interviewed because it enabled the researcher to gather primary data with respect to why students were unable to fully exhibit some competencies (i.e., rubrics on biological drawing) and frequency of organization of Biology practical lesson and the challenges that were associated with the organization of Biology practical activities for the students to acquire biological drawing skills.

3.10 Data Analysis

Both quantitative and qualitative analyses were employed in this study. Quantitative analysis was used to analyze the results from the achievement test. For research question 1, descriptive statistics such as mean and standard deviation was employed in answering this research question. The mean and standard deviation values of students on the various competencies in biological drawings were compared to see their proficiency on the various biological drawing skills and qualitative aspect of this research question was analyzed thematically. Independent sample t-test was used to analyze research question two (2) to find out whether significant difference existed in the achievement of male and female students' proficiency in biological drawing. Independent sample t-test was used to answer research question three (3) to verify whether significant difference existed in the attainment of proficiency in biological drawing skills of students based on the categorization of schools as grade B or C in the study area.

CHAPTER FOUR

RESULTS AND DICUSSION

4.1 Overview

The purpose of the study was to assess the proficiency in biological drawing exhibited by senior high school students in selected senior high schools in Sekyere south district in Ashanti Region of Ghana.

The study used a mixed method research design, thus qualitative and quantitative research technique were used to gather and analyze data. A sample size of 150 SHS 2 students were randomly selected from five schools responded to the research instruments. Additionally, twenty-five students and five teachers were interviewed on the competencies students failed to exhibit on biological drawing to help analyze the qualitative face of the research.

This chapter presents the summary of the analysis of the data collected through the administered Biological Drawing Achievement Test (BDAT). This was carried out under the following sub-headings; answering of research questions and discussion of the findings.

4.2.1 Research Question 1:

What is the level of proficiency exhibited by Senior High School biology students on biological drawings?

Biological drawing is a specialized skill that requires a combination of artistic abilities and a deep understanding of biological structures. In biological drawings there are

competencies that students are required to exhibit. The students' scores on the Biological Drawing Achievement Test (BDAT) were analyzed using descriptive statistics. Students' proficiency in these competency areas were analyzed and expressed in mean and standard deviation. Competencies with a mean score of 2.5 and above are considered as above average and competencies with a mean score below 2.5 are considered as below average. The results are presented in Table 1.

Table 4.1: Mean and Standard deviation of Students' competency in Biological Drawing Achievement Test.(N=150)

Competency	Mean	Standard Deviation
Accurate title	1.11	2.05
Drawing with magnification	3.39	0.75
Accurate features drawn	1.33	2.21
Guidelines touching labelled structure	3.91	0.70
Correctly labelled structure	1.23	1.96
No broken, woolly or rough lines	4.03	0.96
Guidelines not crossing each other	4.53	0.73
No form of shading	1.93	2.38
Guidelines of labels horizontal, having no arrowheads	1.27	2.11

Source: field survey 2023

Table 4.1 shows the mean score students obtained in exhibiting different competencies in biological drawing in the Biological Drawing Achievement Test (BDAT) conducted by the researcher. Each competency was given a total score of 5. As shown in table 1

the mean score of five of the competencies were too low; Accurate title (mean=1.11), Accurate feature drawn (mean=1.33), Correctly labelled structure (mean=1.23), No form of shading (mean=1.93) and Guidelines of labels horizontal, having no arrowheads(mean=1.27).

This gives an indication that these competencies proved to be difficult for the students. With the remaining four competencies (Drawing with magnification, Guidelines touching labelled structure, no broken, woolly or rough lines, Guidelines not crossing each other) showed above average performance, depicting that these areas are not too difficult for the students.

From the analysis of the competencies required in biological drawing, the researcher conducted an interview to find out why students performed poorly in most of the competencies required. Data from interviewing a cross-section of the sampled students (five from each school, totaling 25) and five teachers (one from each school), were used to answer this question. These were presented thematically as follows: Wrong/Missing Title, Shading, Guidelines ruled with arrowheads, Inaccurate features drawn, wrongly labelled structure.

4.2.2 Students and Teachers view on why students made these Errors on Biological Drawing

Wrongly labelled structure

Students view; students blamed their inability to correctly label biological diagram to memory lapses and that they readily forget them after learning.

On the other hand, nine (9) of the students also stated that rushing or carelessness caused them to make mistakes in labelling biological diagrams due to time constraints.

Teachers view; All the five teachers interviewed said lack/inadequate practice led to student inability to label diagrams correctly. They also added that having a lot of practical lessons will help reinforce students understanding and improve their accuracy in labelling biological diagrams.

Wrong Title / No Title

Students view; From the interview with students on why they could not provide heading or appropriate heading for their drawing, some said they forgot to do that because they were in a hurry. Others also simply wrote the name of the specimen instead of adding the transvers, longitudinal section of the specimen (kidney) to the title of the diagram.

Teachers view; Two of the teachers said students' laziness is the reason why they did not provide any heading for the drawing or did it wrongly. The remaining three teachers said they could think of no reason why the students should not provide an appropriate heading for the drawing since they had taught them that it is very important.

Shading

Students view; From the interview, students believe that shading their drawing will help it stand out. Some also were of the view that shading their drawing is the correct thing to do because they have observed some text books that have some parts of their drawing shaded and that they taught it was a good thing for them to adopt.

Teachers view; While four of the teachers could not explain any reason why the students shaded their drawings one of them said some students are just simply stubborn.

No matter the reinforcement to help them to do the right thing, they will always make that mistake. They are simply irresponsible

Guidelines Ruled with Arrowheads / Not Horizontal

Students view; Students had the view that drawing guidelines with arrowheads makes it point to their specific labels and they taught guidelines were unimportant only the labels were required of them. Some students also said they forgot to rule guidelines because they were in a rush. Students that ruled non-horizontal guidelines stated that they were emulating their teacher who uses their free hands in making guidelines on the writing board.

Teachers view; All the teachers interviewed said the students did not rule the guidelines for the labels and some went further to add arrowheads due to plain ignorance. They could not give any justification for this since they said they had taught them the right way to do it.

Inaccurate Features Drawn

Students view; On their inability to draw accurate features, all of the students stated that their inability to draw correct features was due to a lack of drawing skills. Also, they stated that drawing is tough for them, so they sketched anything to reflect what they observed.

Teachers view; In confirmation of what the students said as to why they could not draw features of the specimen accurately, all the teachers also said some students find drawing difficult. Thus, they just draw anything to represent what they see.

WAEC Chief Examiners' Report (2021, 2020, 2018) revealed that inability of the students to follow the rules for making biological drawings such as; improper title, poor labeling, making of woolly, broken, too thick or thin lines, having the relative position of structures or organelles in most cases incorrect thus drawing of inaccurate features among others are responsible for students' poor performance in drawings. The poor labeling of drawings reported by Chief Examiner, according to Dzidzinyo (2022), included using the free hand to make guidelines, giving guidelines arrowheads, as well as not orienting labels horizontally to the top of the page. The student scripts from the test exhibited all of these flaws. The nine competencies that were tested for during the pre-test study include Accurate title, Drawing with magnification, Accurate features drawn, Guidelines touching labeled structure, correctly labeled structure, No broken, woolly or rough lines, Guidelines not crossing each other, No form of shading and Guidelines of labels horizontal, having no arrowheads. Five of the competencies; Accurate title, correctly labeled structure, no form of shading and Guidelines of labels horizontal, having no arrowheads proved to be very difficult for the students.

The results from answering research question one indicated that the reasons given by both students and teachers for the weaknesses exhibited on the biological drawing were varied. Whereas some of the reasons from the two parties overlapped, others were at variance. For instance, on the provision of heading, whereas students said they thought writing the name of the specimen drawn sufficed because that is what they had been doing in class, the teachers said they had taught the proper thing to do. In this instance, since no correction of the mistake had been made by the teachers, the students had taken it to be the correct practice. The biology syllabus advises teachers to help students

practice giving appropriate headings to biological drawings in class when teaching biological drawings (Ministry of Education, Science and Sports, 2008)]. If the teachers are able to do so, such mistakes will not be repeated on external examinations like the WASSCE. On the no shading competence, students said they shaded because they found such in textbooks or they felt they had to make portions of the drawing stand out by shading. This is not surprising since some students even copy textbook drawings when they are required to observe the specimens and draw them. This may mean that either the teachers are not telling them not to shade their biological drawings, or they have been taught but they stubbornly stick to what they consider to be right. Where students have to make some parts stand out on the drawing it is recommended that stippling be used. (Stippling refers to the use of dots to distinguish between parts on a drawing.) Apparently, the students were not aware of any such thing and thus felt justified in using shading instead. The teachers, however, on this subject attributed students' weakness to stubbornness or irresponsibility. With regards to not ruling guidelines with a rule, a section of the students said they were imitating their teachers who tended to rule guidelines with the free hands on the board.

This group of students do have a case on the point. It is well known that students emulate teachers in what they do, especially when it comes to how they present information to the students as reported by Dzidzinyo (2022). Thus, the teachers should practice what they teach the students in class. When they make any drawing on the board and have to label, they should use the chalkboard rule to make the guide lines. The teachers, however attributed this weakness simply to negligence on the part of the students. Since the students do not agree with the teachers on this, it is possible that the teachers do tell the students to use rulers, but contrary to what they say, they (the

teachers) use the free hand when demonstrating it on the chalkboard. Thus, since we learn best by imitating, students copy what they see the teacher doing and somehow unconsciously ignore what the teacher tells them. On the competence of drawing accurate features both teachers and students agreed that students simply lack that skill. However, such students should not be left to their own whims and caprices. They need to be helped to draw by helping them practice constantly. This could be achieved when the teacher gives students a lot of practical exercises that include drawings. This is quite necessary because drawings are obligatory in biology (WAEC, 2000).

The finding also seems to indicate that the teachers were not making use of the annual recommendations of the WAEC Chief Examiners' Reports, which could have updated their knowledge in biological drawing, among other content areas. Hence, the finding provides a plausible reason why biology teachers do not often teach students how to draw biological drawings, as reported by Dempsey and Betz (2001), National Research Council (2012), and Quillin and Thomas (2015). This finding helped to explain a major possible cause of some of the repeated biological drawing errors found in biology candidates' WASSCE answer scripts, as reported by the West African Examinations Council (2021). The current finding appears to be in line with those of prior studies such as Patrick and Tunnicliffe (2014), and Petr and Rokos (2018), Soyibo (1997), Topsakal and Oversby (2012) that have discovered inadequacies in biology teachers' knowledge of biological drawing.

4.2.3 Research Question 2:

What is the difference between sex of Senior High School students and their proficiency in biological drawing?

Table 4.2: Independent sample t-test results on the difference between sex of senior high school students and their proficiency in Biological Drawings

Sex	N	Mean	SD	df	t	p
Male	75	12.73	5.82	148	0.029	0.97
Female	75	12.71	5.30			

Source: field survey

The scores between Male (M=12.73, SD=5.82) and Female (M=12.71, SD=5.30; t (148) =0.029, p>.005) in the proficiency exhibited in biological drawings by students using independent-sample t-test showed no statistically significant difference. This means that the students from the two groups (Male and Female) were performing at similar level after the task was implemented. The implication of this is that, the performance of male and female students in biological drawings is almost the same. Therefore, there was no gender influence in the proficiency exhibited in biological drawings by students.

4.2.3 Research Question 3

What is the effect of school type and the knowledge of biological drawings possessed by senior high school students?

Research question 3 sought to find out the effect of school type and the knowledge of biological drawings possessed by senior high school students. In this study, the school type refers to the Ghana Education Service categorization of schools. Thus, the researcher used category B and C schools. In order to answer this research question, an independent sample t-test was conducted. There were no breaches in the preliminary

assumption tests for normality, linearity, homogeneity of variance. The result is presented in table 3.

Table 4.3: Result of independent sample t-test on the proficiency in Biological Drawings Possessed by Senior High School Student based on school type

School type	N	Mean	SD	df	t	p
Grade B	60	11.83	5.84	118	0.257	0.79
Grade C	60	11.57	5.34			

Source: field survey

The scores between grade B school (M=11.83, SD=5.84) and grade C (M=11.57, SD=5.34; $t(118) = 0.257, p > .005$) in the proficiency exhibited in biological drawings by students using independent-sample t-test showed no statistically significant difference. This means that the students from the two groups (Grade B and Grade C) were performing at similar level after the task was implemented. That is the type of school a student attend is not a condition to determine their proficiency in biological drawings.

4.3 Discussions

Results from research question one indicates that the mean score of five of the competencies were too low; Accurate title (mean=1.11), Accurate feature drawn (mean=1.33), Correctly labelled structure (mean=1.23), No form of shading (mean=1.93) and Guidelines of labels horizontal, having no arrowheads(mean=1.27). This gives an indication that these competencies proved to be difficult for the students. With the remaining four competencies (Drawing with magnification, Guidelines

touching labelled structure, no broken, woolly or rough lines, Guidelines not crossing each other) showed above average performance, depicting that these areas are not too difficult for the students. WAEC Chief Examiners' Report (2021, 2020, 2018) revealed that inability of the students to follow the rules for making biological drawings such as; improper title, poor labeling, making of woolly, broken, too thick or thin lines, having the relative position of structures or organelles in most cases incorrect thus drawing of inaccurate features among others are responsible for students' poor performance in drawings. The poor labeling of drawings reported by Chief Examiners according to Dzidzinyo (2022), included using the free hand to make guidelines, giving guidelines arrowheads, as well as not orienting labels horizontally to the top of the page. The student scripts from the test exhibited all of these flaws. The nine competencies that were tested for during the pre-test study include Accurate title, drawing with magnification, Accurate features drawn, Guidelines touching labeled structure, correctly labeled structure, no broken, woolly or rough lines, Guidelines not crossing each other, No form of shading and Guidelines of labels horizontal, having no arrowheads. Five of the competencies; Accurate title, correctly labeled structure, no form of shading and Guidelines of labels horizontal, having no arrowheads proved to be very difficult for the students. The results from answering research question one indicated that the reasons given by both students and teachers for the weaknesses exhibited on the biological drawing were varied.

Whereas some of the reasons from the two parties overlapped, others were at variance. For instance, on the provision of heading, whereas students said they thought writing the name of the specimen drawn sufficed because that is what they had been doing in class, the teachers said they had taught the proper thing to do. In this instance, since no

correction of the mistake had been made by the teachers, the students had taken it to be the correct practice. The biology syllabus advises teachers to help students practice giving appropriate headings to biological drawings in class when teaching biological drawings (Ministry of Education, Science and Sports, 2008)]. If the teachers are able to do so, such mistakes will not be repeated on external examinations like the WASSCE. On the no shading competence, students said they shaded because they found such in textbooks or they felt they had to make portions of the drawing stand out by shading.

This is not surprising since some students even copy textbook drawings when they are required to observe the specimens and draw them. This may mean that either the teachers are not telling them not to shade their biological drawings, or they have been taught but they stubbornly stick to what they consider to be right. Where students have to make some parts stand out on the drawing it is recommended that stippling be used. (Stippling refers to the use of dots to distinguish between parts on a drawing.). Apparently, the students were not aware of any such thing and thus felt justified in using shading instead. The teachers, however, on this subject attributed students' weakness to stubbornness or irresponsibility. With regards to not ruling guidelines with a rule, a section of the students said they were imitating their teachers who tended to rule guidelines with the free hands on the board. This group of students do have a case on the point. It is well known that students emulate teachers in what they do, especially when it comes to how they present information to the students as reported by Dzidzinyo (2022). Thus, the teachers should practice what they teach the students in class. When they make any drawing on the board and have to label, they should use the chalkboard rule to make the guide lines.

The teachers, however attributed this weakness simply to negligence on the part of the students. Since the students do not agree with the teachers on this, it is possible that the teachers do tell the students to use rulers, but contrary to what they say, they (the teachers) use the free hand when demonstrating it on the chalkboard. Thus, since we learn best by imitating, students copy what they see the teacher doing and somehow unconsciously ignore what the teacher tells them. On the competence of drawing accurate features both teachers and students agreed that students simply lack that skill. However, such students should not be left to their own whims and caprices. They need to be helped to draw by helping them practice constantly. This could be achieved when the teacher gives students a lot of practical exercises that include drawings. This is quite necessary because drawings are obligatory in biology (WAEC, 2000).

The finding also seems to indicate that the teachers were not making use of the annual recommendations of the WAEC chief examiners' reports, which could have updated their knowledge in biological drawing, among other content areas. Hence, the finding provides a plausible reason why biology teachers do not often teach students how to draw biological drawings, as reported by Dempsey and Betz (2001), National Research Council (2012), and Quillin and Thomas (2015). This finding helped to explain a major possible cause of some of the repeated biological drawing errors found in biology candidates' WASSCE answer scripts, as reported by the West African Examinations Council (2021). The current finding appears to be in line with those of prior studies such as Patrick and Tunnicliffe (2014), and Petr and Rokos (2018), Soyibo (1997), Topsakal and Oversby (2012) that have discovered inadequacies in biology teachers' knowledge of biological drawing.

The second research question seek to find the difference between the knowledge of biological drawings possessed by male and female senior high school students. Since the p-value is greater than 0.05 level of significant, it implies that the knowledge of biological drawings possessed by senior high school students in Sekyere South District was not influenced by gender. This finding agrees with the result from the study of Babajide (2010) and Akintola (2018) that gender had no significant influence on the students' achievement in science and knowledge in biological drawing and also supported by Warfa (2016) who found that no significant difference between male and female students academic performance in Biology but disagrees with the studies of Ezirim (2006) and Ayodeji (2010) that a significant difference existed in the achievement of male and female students. This is an indication that biological drawings could be learnt successfully through both male and female biology students, and that the performances of students in biological drawings are not based on whether you are a male or female student. Another study has reported no significant gender disparities in the acquisition of drawing skills, suggesting that gender may not be a determining factor in skill development (Powell & Ansic, 1997).

The findings of Adewale, Nzewuihe, & Ogunshola (2016) reveal that in practical courses, the male gender achieves better than the female gender, although slightly that it is not even statistically significant.

Wekesa (2013) is of the opinion that gender has no effect on the level of interest of students but gender had effect on the area that the students have interest in. He further stated that the male gender was less interested in environmental protection, human

biology, and health issues but had more interest in ecology and evolution as well as cell biology and gene.

Several studies have investigated the potential gender differences in students' acquisition of drawing skills in biology. It has been suggested that male students may exhibit higher confidence and familiarity with laboratory procedures, which can contribute to their perceived advantage in practical work (El-Emadi, Said, & Friesen, 2019).

Participation rates in biology practical work have also been examined in relation to gender. Some research has found that female students may be less likely to actively engage in practical tasks compared to their male counterparts (Doucette, Clark, & Singh, 2020). Factors such as social norms, stereotypical expectations, and perceived gender roles may contribute to this discrepancy. However, it is important to note that these findings are not consistent across all studies, and there are instances where female students have demonstrated equal or higher levels of participation in biological drawing.

The third research questions examined the effect of school type and the knowledge of biological drawings possessed by senior high school students. Category B and C schools that are located in the study area were examined to find out if the type of school has an influence on students' knowledge in biological drawing. Since the p-value is greater than 0.05, it was concluded that the difference is insignificant. This implies that there was no significant difference in the knowledge of biological drawings of senior high school students based on their school type. The finding of this study is consistent

with a finding by Eshun and Amoah (2018) that school type was found not to be significantly related to the performance of the students at interpreting skills in their study. Keeves (1978) subscribed that the type of school, classified as grade A or B did not make any difference in the determination of students' academic performance.

The result of this finding disagrees with that of Oginni (2012), Jegede (2007) and Okonkwo (2002) that student from schools that are classified as grade B in urban areas performed better than students from schools that are classified as grade C in rural areas. As shown in this study, it appears that whether a pupil attended a grade B or C school does not matter. What have been found to be related to students' performance are the facilities available in the course of program implementation. It could be that most of the grade C schools are now putting up more facilities like laboratory, classrooms and recruiting professional teachers to offset lapses so as to compete with the grade A and B schools. As in the case of school categorization in Ghana most grade A schools are found in the urban and B, C schools in the rural areas. The results obtained, could be due to the facts, no matter the category of school whether grade B or C, school in the study area are equally staffed with more qualified biology teachers as this schools are located in a mid-rural-urban community where teachers are willing to stay and work. Also, students from schools located in the study area whether grade B or C school have equal access to laboratory facilities, text books among others that aids students learning. This could be the reasons for comparable performance in the two types of schools

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Overview

This chapter presents the summary of findings, recommendations, conclusions and suggestion for further studies.

5.2 Summary of Findings

From the research question 1, it was revealed that majority of the students performed low/poorly on rubrics of biological drawing. Response of Biology Teachers and students in connection with the interview on the competence level of students on biological drawing, it became apparent that practical activities were not regularly organized for the students and therefore, the probability that Biology students would perform poorly in biological drawing was high. This implies that students did not engage in biology practical work leading to insufficient knowledge and understanding of the required drawing skills.

According to the Teachers factors that influence effective organization of Biology practical activities were time constraints for biology practical activities, overloaded Biology curriculum, large class size of Biology students, unavailability of qualified Biology laboratory assistants, unavailability, inadequate and mal-functioning equipment and materials for Biology practical work, and unavailability of or non-release of funds for Biology practical activities.

From research question two, on the knowledge of biological drawing possessed by male and female students, there was no statistically significant difference between the mean score of male and female students on biological drawing. Male and Female performing at the same level on drawing could be attributed to the fact that the male and female students were exposed to biological drawing almost at the same level in their various schools and hence their parallel level in the attainment of drawing knowledge. Overall, the practical aspect of biology is a crucial component that both male and female students need to master in order to succeed in their overall biology exams. With respect to Research Question 3, the performance of students from grade B and C schools showed no significant difference in the analysis of this research question.

5.3 Conclusion of the Findings

The study confirmed what the literature report to be the errors of students on biological drawings. According to literature, biology students' shortcomings on drawings include diagrams drawn out of proportion, labeled poorly, with relative position of structures or organelles in most cases not correct. However, in addition to what the literature reports to be students' weaknesses on biological drawings, the study found out that students had the most difficulty with providing an appropriate heading for the drawing, avoiding any form of shading, and making ruled guidelines with no arrowheads. The findings of the study are of much importance to teachers. This is because they serve as enlightenment for biology teachers on the various mistakes their students make in the areas of biological drawings. They are also of significance to biology students, since they help them identify their own strengths on biological drawings and address them to the best of their knowledge.

The study also concluded that; the knowledge of biological drawings possessed by senior high school students was poor and students lack the basic skills required in biological drawing, gender do not influence the knowledge of biological drawings possessed by students and students from category B and C schools showed no significant difference in their performance in biological drawings. This means no matter the category of school students could perform better when they receive better facilities and service of teachers of better quality. It is therefore imperative to prioritize and improve laboratory facilities and equipment that are functional in both Grade B and C schools to aid the teaching and learning of biological drawing and biology in general.

5.4 Recommendations

From the research certain recommendations were reached based on the study findings, and it include the following:

Biology teachers and their students in Sekyere South District should go the extra mile in ensuring that the rubrics of drawing are at students' fingertips. Teachers can do this by taking students through a lot of practical with enough exercises on drawing and ensuring that such exercises are marked and discussed in class with students.

Biology teachers in Sekyere South District should try as much as possible to use the Chief Examiners' reports in their teaching so that weaknesses pointed out by the examiners will be taken care of. This will help students avoid repeating them. There should be frequent school-based in-service training program as well as organization based in-service program for Biology teachers in Sekyere South District to be equipped with the relevant skills to effectively organize practical activities for the students to attain biological drawing skills.

5.5 Suggestions for Further Study

Further studies can be conducted using pretest/posttest designs so that there will be a baseline assessment for the intervention.

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APPENDICES

APPENDIX 1

BIOLOGICAL DRAWING ACHIEVEMENT TEST (BDAT)

SECTION A; BACKGROUND INFORMATION

School Code.....

Type of school: 1. Grade **B** []

2. Grade **C** []

Age:.....

Sex: Male [] Female []

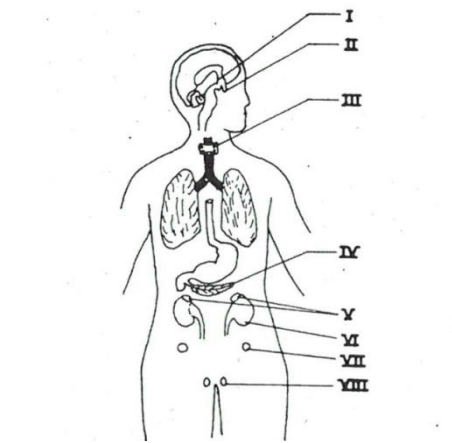
Class: S.S.S 2

Time allowed: 60 minutes

Instruction: This BDAT is to test your drawing skills in Biology. Ensure that you complete the section A (**Background Information**) on the answer sheet provided and attempt all questions given.

QUEST. 1

The diagram below is an illustration of a system in the human body. Study it and answer the questions that follows



a. Name the system illustrated in the diagram

b. Name the parts labeled I to VIII

I.....

V.....

II.....

VI.....

III.....

VII.....

IV.....

VIII.....

QUEST. 2

Make a drawing, 8cm-10cm long of specimen M and label fully. (M=Kidney)

(15MARKS)

Specimen M is a kidney

- a) Cut the specimen into two longitudinal sections
- b) Make a detailed drawing 8-10cm long of the longitudinal section of specimen M and label all the parts
- c) Calculate the magnification

QUEST. 3

Make a drawing 8cm-10cm long of the transverse section of specimen T and label fully

(T=orange, lemon, lime or any other citrus) **(15MARKS)**

Specimen T is orange

- d) Cut the transverse of the specimen

- e) Make a detailed drawing 8cm-10cm long of the transverse section of specimen
- f) Label all parts
- g) Calculate the magnification

APPENDIX 2

MARKING SCHEME FOR BIOLOGICAL DRAWING ACHIEVEMENT

TEST

QUESTION 2.

Title (TL)-----1MRK

Quality (Q)

Clarity of lines (CL)-----1MRK

Neatness of label (NL)-----1MRK

Correct Size (SZ) 8cm-12cm-----1MRK

Magnification (MG) (x1-1^{1/2})-----1MRK

Details (D)

Bean shaped kidney (BS)-----2MRKS

Three regions shown (TR)-----3MRKS

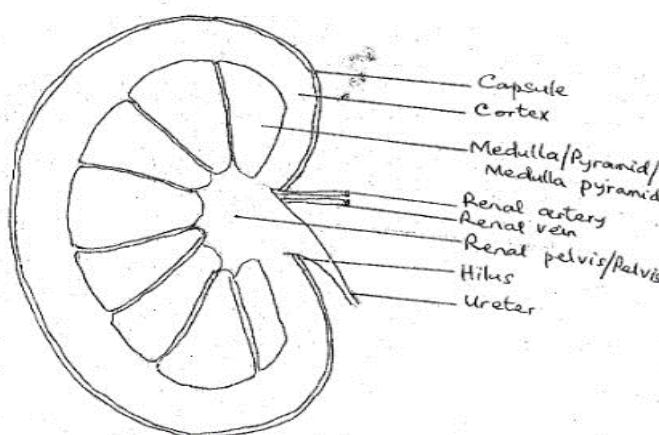
Labels (L)

Cortex; Medulla/Pyramid/Medulla Pyramid; Pelvis/Renal Pelvis; Ureter; Renal artery;

Renal vein; Hilus Capule.-----5MRKS

TOTAL =15MRKS

(c) Drawing/Diagram of longitudinal section of Specimen M/Kidney



QUESTION 3.

Quality (Q)

Title (TL)-----1MRK

Clarity of lines (CL)-----1MRK

Neatness of label (NL)-----1MRK

Correct Size (SZ) 8cm-12cm-----1MRK

Magnification (MG) ($x^{1/2}$ - x^2)-----1MRK

Details

Cut surface with double lines (CS)-----2MRKS

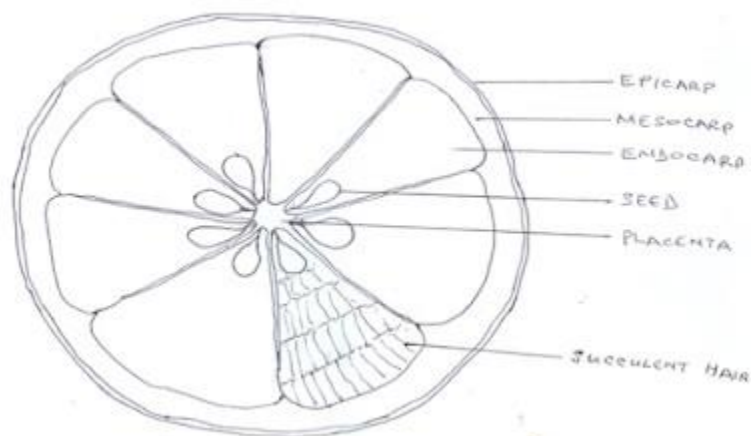
Placenta shown (PS)-----2MRKS

Juice sac/ succulent hair shown (JS)-----2MRKS

Labels

Epicarp; mesocarp; endocarp; placenta; seed-----Any 4x1=4MRKS

TOTAL =15MRKS



APPENDIX 3

THE SCORING RUBRICS FOR COMPETENCY LEVEL OF THE BIOLOGICAL DRAWING IN BIOLOGICAL DRAWING ACHIEVEMENT TEST (BDAT)

SECTION A; BACKGROUND INFORMATION

School Code.....

Type of school: 1. Grade **B** [] 2. Grade **C** []

Age:..... Sex: Male [] Female []

The (BDAT) was rated using scoring rubrics which ranged from 0 to 5 points. A score of 5 points indicate excellent level of competence, 4 points indicate very good level of competence, 3 point showed good level of competence, and 2 points indicate a fair level of competence, 1 point showed a poor level of competence and 0 showed no acquisition of level of competence.

s/n	Performance Criteria	1	2	3	4	5
1	Accurate title					
2	Drawing with magnification					
3	Accurate features drawn					
4	Guidelines touching labelled structure					
5	Correctly labelled structure					
6	No broken, woolly or rough lines					
7	Guidelines not crossing each other					
8	No form of shading					
9	Guidelines of labels horizontal, having no arrowheads					

APPENDIX 4

INTERVIEW GUIDE FOR STUDENTS

INTRODUCTION

This interview guide seeks information on why students failed to exhibit some of the competencies regarding Biological Drawing as well as the factors that affect the effective organization of Biology practical lessons for the students to acquire biological drawing skills. This exercise is for research purpose and, therefore, the information provided will be treated with confidentiality. You are therefore required to be honest with your response in order to improve upon biological drawing skills and organization of biology practical. Thank you.

SECTION A; BACKGROUND INFORMATION

School Code.....

Type of school: 1. Grade **B** [] 2. Grade **C** []

Age:..... **Sex:** Male [] Female []

**SECTION B: REASONS FOR STUDENTS INABILITY TO EXHIBIT
SOME BIOLOGICAL DRAWING COMPETENCIES**

1. What account for students inability to correctly label Biological drawing?

.....
.....
.....

2. What account for students inability to provide heading or appropriate heading for their drawing?

3. What makes students shade their drawing?

.....
.....
.....

5. What reasons account for Guidelines ruled with arrowheads or not horizontal?

.....
.....
.....
.....
.....

6. What account for students inability to draw accurate features?

.....
.....
.....
.....

SECTION C: FREQUENCY OF BIOLOGY PRACTICAL LESSONS

1. How frequent do you carry out Biology practical activities?

.....
.....

2. Approximately, how many practical activities do you carry out in a term?

.....
.....

3.a Do you have a laboratory for Biology practical activities? Yes [] No []

b. If yes, is the laboratory equipped with the necessary materials and tools for Biology practical activities?

A. Yes []

B. No []

4. If you are not having a laboratory for practical activities, where do you carry out Biology practical activities?

.....

.....

.....

APPENDIX 5

INTERVIEW GUIDE FOR TEACHERS

INTRODUCTION

This interview guide seeks information on why students failed to exhibit some of the competencies regarding Biological Drawing as well as the factors that affect the effective organization of Biology practical lessons for the students to acquire biological drawing skills. This exercise is for research purpose and, therefore, the information provided will be treated with confidentiality. You are therefore required to be honest with your response in order to improve upon biological drawing skills and organization of biology practical. Thank you.

SECTION A; BACKGROUND INFORMATION

School Code.....

Type of school: 1. Grade **B** [] 2. Grade **C** []

Sex: Male [] Female []

Academic Qualification.....

Professional Qualification.....

Teaching Experience.....

**SECTION B: REASONS FOR STUDENTS INABILITY TO EXHIBIT
SOME BIOLOGICAL DRAWING COMPETENCIES**

1. What account for students inability to correctly label Biological drawing?

.....
.....
.....

2. What account for students inability to provide heading or appropriate heading for their drawing?

.....
.....

3. Whats makes students shade their drawing?

.....
.....
.....
.....

4. What reasons account students ruling Guidelines with arrowheads or not horizontal?

.....
.....
.....
.....

5. What account for students inability to draw accurate features?

.....
.....

SECTION C: FREQUENCY OF BIOLOGY PRACTICAL LESSONS

1. How frequent do you organize Biology practical activities for your students?

.....
.....

2. Approximately, how many practical activities do your students carry out in a term?

.....
.....

3.a Do you have a laboratory for Biology practical activities? Yes [] No []

b. If yes, is the laboratory equipped with the necessary materials and tools for Biology practical activities?

A. Yes []

B. No []

4. If you are not having a laboratory for practical activities, where do you carry out Biology practical activities for your students?

.....
.....
.....

5.a. Do you have separate periods for teaching the theory and practical lessons in Biology on your school time table?

A. Yes []

B. No []

b.i. If yes, how many times do you have practical activities in a week?

.....
.....

b.ii. If no, what time do you organize Biology practical activities for your students?

.....
.....

c. If instructional periods are used for practical activities, do your students get enough time to carry out the practical activities? Give reasons for your answer.

.....
.....
.....