UNIVERSITY OF EDUCATION, WINNEBA

USING COMPUTER-ASSISTED INSTRUCTIONS TO IMPROVE STUDENTS' COMPETENCIES IN SPECIMEN IDENTIFICATION, BIOLOGICAL DRAWING AND LABELING

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MASTER OF PHILOSOPHY

2020

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A thesis in the Department of Science Education, Faculty of Science Education, submitted to the School of Graduate Studies in partial fulfillment

of the requirements for the award of the degree of Master of Philosophy (Science Education) in the University of Education, Winneba

JUNE, 2020

DECLARATION

STUDENT'S DECLARATION

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

STUDENT'S SIGNATURE: …….....

DATE: ……

SUPERVISOR'S DECLARATION

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

NAME OF SUPERVISOR: REV. DR. JOSEPH NANA ANNAN

SIGNATURE: ……

DATE: ……

DEDICATION

I dedicate this work to my adorable daughter, Marvella Adwoa Ampofo who was born during my MPhil programme. It is the miracle and favour she brought that has brought me this far.

ACKNOWLEDGEMENTS

I thank the Almighty God, my heavenly father for his favour, because I could not have made it without HIM, especially during the gloomy and stormy times of the past few months. I thank Him for blessing me with loved ones such as Mr. Charles Ohene Amoh, who supported and encouraged me throughout the process of writing the thesis. I thank him for inspiring me to work harder and for sacrificing his time and energy just to see me succeed.

I would also like to give Special thanks, respect, and heartfelt gratitude to various individuals who have been actively involved in the research process and various stages that have culminated in the development of this thesis report. The first one goes to Rev. Dr. Joseph Nana Annan for being my supervisor.

I also acknowledge my husband, Mr. Eric Ampofo and my children, Louis Ampofo, Vanessa Ampofo and Elizabeth Ampofo for their financial and moral support during the long hours of intense devotion to my study and research. My sincere gratitude to Mrs. Nelly Sakyi Hagan and brother Adjei Kumi Nelson for spending time to review the final draft, and my mother, Mrs. Margaret Anguh for her moral support during my studies. Last but not the least, I acknowledge the many students that I have had privilege to teach and who often express incompetence in their skill in Biology practical's more so in the light of the weight borne by the practical paper at West Africa examination council (WAEC) got me concerned, hence the research.

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LIST OF ABBREVIATIONS

WAEC	:	West Africa Examination Council
BECE	:	Basic Education Certificate Examination
CTL	:	Constructivist Learning Theory
SDT	:	Social Development Theory
GES	:	Ghana Education Service
CAI	:	Computer Assisted Instruction
BYOD	:	Bring Your Own Device
TPACK	:	Technological Pedagogical Content Knowledge
ICT	:	Information Communication Technology
W1-W35	:	Codes given to students (Winnesec 1-35)
HB	:	Hard Black
TV	:	Television
LCD	:	Liquid Crystal Display
DVD	:	Digital Versatile Disc
SHS	:	Senior High School
SD	:	Standard Deviation
MPEG	:	Motion Picture Expect Group
MPhil	:	Master of philosophy
CBI	:	Computer Based Instruction

ABSTRACT

The successes of students in biology in the West African Secondary School Certificate Examinations over the years have been very discouraging. Studies have specified that this is partly due to the poor knowledge of students in biological drawings, labeling and identification of specimen. Indications in the literature revealed that biological drawings labeling and identification could be used to facilitate students' learning. This study, therefore, evaluated the knowledge of biological drawings, labeling and identification possessed by Senior High School students in Winneba Senior High School. Action research method was employed. The population for the study was all Biology students in Winneba Senior High School. A sample of 35 Biology students were used for the study. The instruments used were questionnaire, observation, interview and tests. The research was conducted in three phases, the pre- intervention phase, the intervention phase and the post- intervention phase. Three research questions were answered. Findings of the study showed that: students possessed poor of biological drawings, labeling and identification and the use of CAI was able to improve the competencies of the sampled students. The study concluded that Students' drawing skills were improved, in that, there were no more shading, there was a reduction in the use of wavy and double lines, the correct pencils were used and also students were able to make proportional drawings. The labeling skills of students' were also improved. Label lines were neatly drawn with rulers, label lines were no longer having arrow and label lines were not crossing each other. Students' identification skills were also improved, they were able to identify specimen easily and faster. It was recommended that teachers should make themselves available to new technologies such as Computer- Assisted Instruction and other computer software in other to be abreast with time. They should always be around to supervise students when they are using computers to learn because some students may do something else with the computer rather than learning.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter discussed the background to the study which included students' learning difficulties in identifying specimen, making drawings and labeling in Biology, statement of the problem, purpose of the study, objectives and research questions of the study. The rest would be the limitations, delimitations, and definitions of terms.

1.1 Background to the Study

Biology is a science in which the curriculum continuously changes (Barrow, 2006). New knowledge and emerging content have an enormous impact on our lives. Biology is therefore a subject filled with interesting phenomena, appealing experimental activities, and fruitful knowledge for understanding the natural and industrial world. Interestingly, aspects of the subject entail the identification of specimen, drawing of various specimen such as insects, plants and other living organisms and labeling them correctly.

Correct identification of specimen, drawing and labeling in biology are very important aspects of the subject that cannot be over emphasized. They are the aspects in which success is a matter of following the rules. Learning to identify specimen correctly, drawing and labeling in biological science can be compared with learning to play the piano. Certain rules must be observed. Breaking the rules will not lead to good illustrations or artistry work. Aspiring pianists who attempts to depart from the fundamental rules before learning the basic harmony will not succeed in becoming an artist or a good pianist. Just so, the biological illustrator who wishes to identify, draw and label without learning or observing the rules of drawing will experience undue

difficulties in trying to achieve a satisfactory illustration and will lose much time in making corrections.

Most biology students however, perceive the identification of specimens, drawing and labeling aspect of the subject to be very difficult (Barrow, 2006). It is therefore, important to appreciate the various areas of difficulties as expressed by students. The biological drawing, identification and labeling aspect of the subject are by themselves very practical, concrete and complex. Areas such as mammalian anatomy and physiology, life processes of living things, structure and life processes of some organisms and cell biology are some of the areas where specimen identification, drawings and correct labeling are needed to facilitate easy understanding and so while much can be acquired by rote learning (this often being reflected by efficient recall during examinations), real understanding and perfect identification of specimen, drawing and labeling demand the conceptual understanding of the various associated processes.

According to Barrow (2006), students face difficulties to understand concepts in biological specimen identification, drawing and labeling because, some teachers are not able to connect students' prior knowledge in the classroom. Since the initiation of the Senior High School programme in Ghana, biology has always been studied as an elective Science subject. In the 1987 Education Reform programme, it was indicated that Senior High Schools were established to replace the British-based O-level and A-level system. In 1999, subject combinations were greatly liberalized permitting combinations that had previously been impossible. Elective subjects from general science could be taken with other programmes and therefore biology and chemistry were added to agriculture.

Unfortunately, since the inception of the programme, most senior high schools established to pursue the science programme might have been facing various kinds of problems like inadequate laboratory equipment and the necessary facilities. These might have resulted in the use of inappropriate teaching methods in teaching biology practical and the associated hands-on skills. It is in view of this that the researcher has been prompted to consider the appropriate methods of teaching specimen identification, drawing and labeling in Biology. The researcher used computers and computer programme such as YouTube and others that allow students to study easily and to view specimen clearly to improve the teaching and learning of drawing, labeling and specimen identification in Biology in the senior high schools.

The researcher, having taught biology for about five years now, noticed that many students fail in biology because they do not perform well in the practical aspect of the paper. This is seen both in the end of term examinations and the final WAEC examinations. Since 1987, the West Africa Examination Council (WAEC) chief examiners' reports have shown that more students fail in biology because they do not perform creditably in the Paper 2, which was the practical Paper. The Paper 2 which has been changed to Paper 1 from 2011 to 2015, and again changed to Paper 3 in 2016, tests students skills in specimen identification, drawing and labeling, classification and the interpretation of biological data and phenomena. The results indicated that students were either not taken through the practical lesson during their years of studies or they did not take their practical lessons seriously whiles in school (WAEC, 2015).

1.2 Statement of the Problem

Several studies have shown that high school students perceive science knowledge as either right or wrong (Bernama, 2012). Unfortunately, biology concepts are rarely this clear-cut and the body of knowledge in biology is ever changing. Biological systems are dynamic, and long-term observations are often needed to understand and make sense of the evidence, making learning of the subject difficult for most students. Accurate identification of specimen, good drawing and labeling are those that abridge, highlight, review and explain most biological concepts. For these explanations, consideration to the smallest feature is precisely significant. Biological drawings are not destined to be artistic masterpieces but are more like graphic notes that help record a set of observations.

As such, these observations must be accomplished in class with the specimen directly observable and they are supposed to be accurate and based on real living things or fossils. The idea behind a biological drawing, labeling and identification of specimen is to communicate what is seen, and the extent to which this is accomplished determines the usefulness of the illustration. The primary requirement for any artist, and especially for the science artist, is a well-developed power of observation.

The 2015 Chief Examiner's report of West African Examination Council (WAEC, 2015) indicated that biology students have difficulty in learning biology. This has reflected in the low grades obtained by students during the end of term examinations in most schools in the country. Some of the weaknesses outlined by the chief examiner report over the years (1994-2017) are as follows:

(i) Candidates' answer show that they had not been taken through adequate practical lessons.

(ii) Students' answers indicate that they had not done any practical work along the lines of test items.

(iii) Candidates' wrote unobservable features. Thus, they answered practical questions from the theory they had learnt.

(iv) The standard of drawing and labeling that students presented were poor. This indicated that they did not practice biological drawing and labeling as required by the practical examination.

Also, students found it difficult to spell biological terms, draw structures of organisms under study and label them correctly, use the simple light microscope, perform simple practical experiments and solve simple graphical problems (WAEC, 2015), these were comments from the 2015 Biology chief examiner.

This problem has led to many students failing in biology which could have been avoided if certain issues have been corrected. Considering the evidence outlined above on students' difficulties in biology, it is clear to note that some biology students in the Senior High Schools find it difficult to grasp simple biological concepts such as how to identify simple biological specimen, make simple biological drawings and label the correctly which results in failure in examinations.

This study therefore sought to improve on students' competencies by investigating the causes of students' difficulties in identifying simple biological specimen, making biological drawings and labeling them correctly in the selected senior high school and improve the gap by making important recommendations that will help solve this problem.

1.3 Purpose of the Study

The purpose of the study was to use computer-assisted instruction to improve students' competencies in identifying simple biological specimen, making drawings and labeling correctly in Winneba Senior High School. The study looked at the facilities available to the students for use in the school and the methods used in the teaching and learning the biological drawings identification and labeling aspect of biology.

1.4 Objectives of the Study

Objectives of the study were to:

1. Examine the methods teachers use to teach identification of specimen, drawing and labeling in biology.
2. Ascertain the extent to which students know the rules to be observed in the identification of specimen, drawing and labeling in biology.
3. Examine the effect of computer- assisted instructions on the performance of students.

1.5 Research Questions

The study was guided by the following research questions:

1. What are the methods employed by teachers to teach identification of specimen, drawing and labeling in biology?
2. To what extent do students know the rules to be observed in the identification of specimen, drawing and labeling in biology?
3. How can computer- assisted instructions improve students' competencies in identification of specimen, drawing and labeling in biology?

1.6 Significance of the Study

The outcome of the study would be very important in the teaching and learning of identification of specimen, drawing and labeling in the Senior High Schools. First of all, it would identify the problems associated with lack of understanding the pre-requisite concepts of students which make it difficult for them to identify, draw and label specimens effectively in Biology at Senior High levels.

It would also assist teachers and students to take appropriate steps that will enable them teach and learn identification of specimen, drawing and labeling effectively. The study will also inform the teachers to use the Computer- Assisted Instructions (CAI), power point and other computer software to make teaching and learning of specimen identification, drawing and labeling in Biology easy.

It is hoped that the findings of the study would be of value to stakeholders in education such as teacher trainees, tutors of Science Colleges of Education (SCOE), Education Officers, the Teacher Education unit of the Ministry of Education and other higher institutions in Ghana, which train teachers to teach science in general and Biology in particular. It will also help future researchers to investigate more into the topic in finding out some other learning difficulties in Biology that will not be captured under this study.

1.7 Delimitations

The researcher, due to insufficient time, was not be able to use other parameters to determine their low grades in Biology but depended solely on WASCE results from their 2014/15 and 2015/16 Academic years. Also, only one out of the two senior high schools in the Effutu municipality was involved in the research and the results of the study is not considered as the findings from all the senior high schools in the district.

1.8 Limitations

The Senior High School has only about 10 per cent of its students offering biology. About 30 percent are day students and about 80 per cent of the biology teachers are also non-resident and this made the accessibility of students and teachers very difficult. The resources and time frame for the study to be conducted did not permit the researcher to involve all the Biology students and teachers.

1.9 Definition of terms

In the context of this study the listed terms was defined as suggested;

Achievement is the feedback expected after learning. The mark awarded in the test is viewed as achievement in the study. At WAEC, achievement is graded using grades A to F, where A is the best and F is the worst achievement grade.

Biology syllabus refers to the recommended program of learning Biology as outlined by WAEC.

Competence is the ability to do Biology practical tasks so as to show expected mastery of skills under review.

Skill is a developed proficiency acquired through specific training.

Practical skill is activity that involves operations and manipulations, through which one replicates or demonstrates a scientific process or theory.

Practical Procedure is the knowing of the items and manipulations required in carrying out a particular practical task.

Practical Execution is the carrying out of the manipulations in a task.

Practical Observation is the noticing and paying attention to results got in a task.

Practical Interpretation is the explanation of observations made in a particular task.

YouTube Account: With an account, users can comment on videos, subscribe to channels and create playlists to organize their favorite videos. If an individual has a Google account, they will have a YouTube account.

Subscriptions: This feature allows an individual who is signed in to their YouTube account to customize their homepage with content they wish to see. By subscribing to channels, it allows the viewer to see the new content when it is uploaded, which will appear on the subscription feed on the homepage.

Channel: A YouTube channel is a homepage for an account. All YouTube accounts have a channel page that shows the account name, type of account, all videos uploaded and any information that has been entered by the user. Channels can be customized with banners and colours, and they also display playlists and activity logs.

Playlists: Playlists are a feature offered by YouTube that allows videos to be collected and organized together to be watched whenever the user wants. The user can create playlists, title them and then add videos to the playlist. Standard playlists are available for all users including a 'favourite' playlist and a 'watch later' playlist.

1.10 Organization of the study

This paper is organized in five chapters.

Chapter one provided a concise background to the study including the research questions, objectives, and significance of the study.

Chapter two sets out the theoretical framework and the critical discussion of the factors leading to poor specimen identification, poor biological drawings and poor labeling skills among biology students, and how to handle those factors in order to improve academic performance of students under study.

Chapter three covers the methodological approach employed and the methods used to collect data for the research. It discusses the research design; this is followed by a discussion of the quantitative and qualitative approaches.

Chapter four analyzes and discusses research findings with respect to the factors affecting the performance of students in WASCE.

Chapter five draws a conclusion with a presentation of summary of key findings.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter reviews and discusses related issues in the literature relating to learning difficulties in drawing, labeling and identification of specimen in biology. The review looked briefly at the conceptual understanding of biological drawing, labeling and identification of specimen, using technology, the role of constructivism in teaching and learning of Biology in general, drawing, labeling and identification of specimen in particular, and also, the role of practical activities in Biology lesson delivery and concept formation.

Further, the development of tools for solving problems faced by students in Biological drawing, labeling and identification of specimen was also reviewed. This review sought to bring together some of the main findings from research over the past few decades, attempting to establish some key general principles which may be of value in curriculum development and for policy makers, teachers, teaching strategies as well as in generation of more research work. An examination of the aims of each study revealed the motive of the researchers who undertook the study.

2.1 Conceptual Framework

Traditionally, students struggle to learn some of the basic ideas taught in high school biology classes (Barrow, 2006). To understand why, we must analyze not only the content itself but also the classroom conditions and learning environment. One concern cited by biology teachers is the “overstuffed” Biology curriculum. Because of the sheer amount of information that is taught related to each topic, even good students find it difficult to retain what they learn (Bernama, 2012). Because of an

emphasis on a fact-based biology curriculum, instruction often relies on direct instruction to cover all of the material. As a result, students have limited practical experiences and therefore find it more difficult to practice more drawing, labeling and specimen identification in Biology and they hardly ever retain what they learned, pass the quiz or unit test. Certain Biology topics involve more practical, experiments, investigations and drawings which are hard for students to learn because students aren't given the time they need to think, practice, draw and process learning (Figure 2.1).

We must give students multiple opportunities to engage with ideas, manipulate and practice what they learn. Research suggests that students need at least four to six experiences in different contexts with a concept before they can integrate the concept and make sense of what they are learning (Bialek & Botstein, 2004). Another reason is that there are hard to teach (and learn) topics that relates to the prior knowledge of our students.

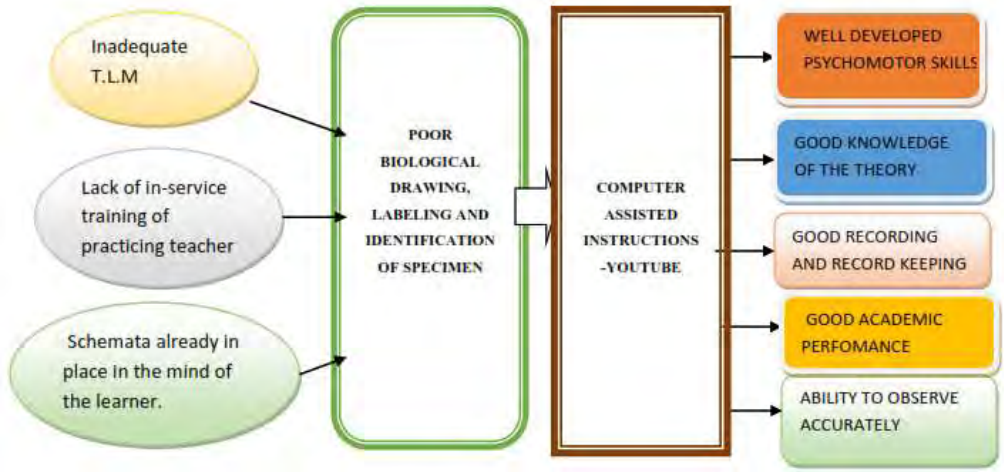

Figure 2.1: Conceptual Framework of poor Biological Drawing

Source: Authors' Own Construct

High school students are far from being blank slates; they come to us with their own ideas and explanations about biology principles (DeHaan, 2009). After all, everyone knows something about biology and our students have had a variety of experiences both as they have grown up outside school and in previous science classrooms. Student preconceptions can be incomplete and students often hold onto them persistently. One classic research study was captured in the video 'A Private Universe: Minds of Our Own' (Chiel, McManus & Shaw, 2010). In one segment, researchers asked Harvard graduates where the mass of a log came from. The response was water and nutrients from the soil. Students and even college graduates hadn't learned the fundamental concept that photosynthesis requires carbon dioxide from the air to manufacture carbohydrates, which are the basis for the vast majority of a tree's mass. This example relates to two additional reasons why some biology topics are hard to teach.

One, many biology practical lessons are highly conceptual and students can't visualize what is taking place on a microscopic level. And two, some biology teachers are not aware of strategies that engage students with a scientific way of knowing (Bialek & Botstein, 2004). Such strategies to manage this include asking questions, inferring from data, challenging each other's ideas, communicating and inquiry results, synthesizing student explanations with scientific explanations and finally making illustrations, diagrams and drawings of what they have learnt. When we consider these various impeding factors, it is no wonder that students struggle in our biology practical lessons (Figure 2.1).

2.2 Theories Underpinning the Research

In order to construct an ideal-typical model on specimen identification, drawing and labeling in biology the Kolb's Learning Cycle Theory and the Constructivist Learning Theory (CLT), guided the study. Two of the most revered scholars/pieces of scholarship in the discipline of learning and education.

2.2.1 Kolb's Learning Cycle Theory

This study is underpinned by Kolb's Learning Cycle Theory. Kolb's learning cycle theory (1976) describes the stages of learning as knowledge, experience and skills are acquired. This perspective of learning is called 'experiential learning' or 'learning by doing' and relates to constructivist learning. The cycle can begin from any one of the four stages (feeling, watching, thinking or doing,) and link to any other stage.

- Watching (reflective observation)
- Thinking (abstract conceptualization)
- Doing (active experimentation)
- Feeling (concrete experience)

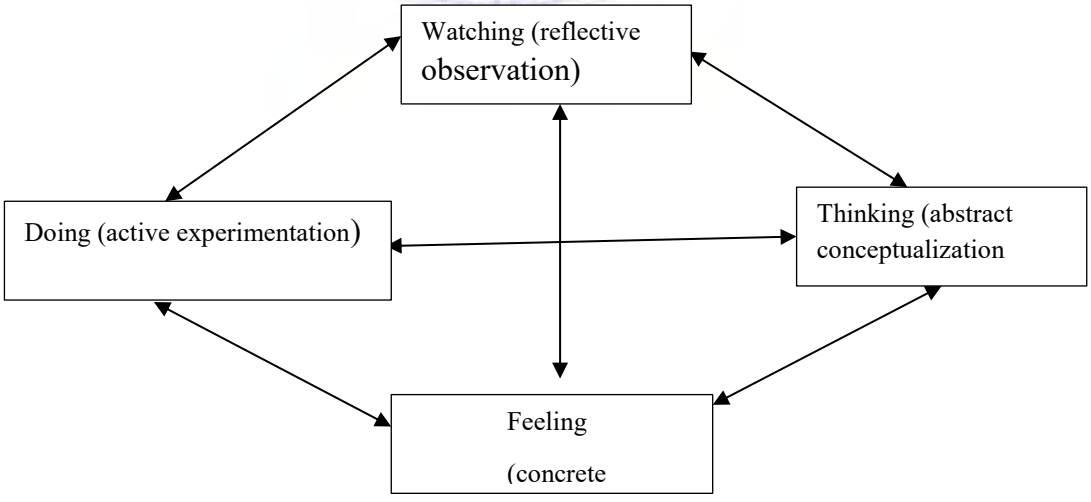

Figure 2.2: Kolb's Learning Cycle Theory

Source: Kolb (1976)

In Kolb's learning cycle (Kolb, 1976 and 1984), four stages (or modes) of learning are identified. Learners are involved in new experiences (also known as concrete experience). Again, learners must make or have time and space to be able to reflect on their experiences from different perspectives (also known as reflective observation), Learners must be able to form, re-form and process their ideas, take ownership of them and integrate their new ideas into sound, logical theories (also known as abstract conceptualization). Learners need to use understanding to make decisions, solve problems and test implications in new situations (also known as active experimentation). These activities generate material for the starting point of the next round, concrete experience Learners tend to differ in their tendencies and preferences to learning due to personality, cognitive processes and prior learning experiences.

This theory (Kolb, 1976) is perfectly linked to the present study in that for every student to make good specimen identification and biological drawing him or she has to watch the object or specimen to be identified and drawn critically, think about it before the identifications and drawings are made. A good drawing will lead to a concrete experience.

2.2.2 The Constructivist Learning Theory (CLT)

The Constructivist Learning Theory (CLT) will also guide this study. The theory is highly developed by Lev Vygotsky, a Russian psychologist (1896-1934) who also came up with Social Development Theory (SDT) which is applied in education (Bruner, 1996). Constructivism is an active procedure whereby teacher guide the learners to create their own new information from previous knowledge during learning. The constructed knowledge in this study is procedure, observation, execution and interpretation skills used in selected tasks that constitute the

independent variables while achievement or performance in the skills tested constitutes the dependent variable. This type of learning proposed by Vygotsky is a give-and-take experience for the teacher and the students. It places emphasize on the affective domain, makes instruction significant to the learner, it also help learners build up beliefs and attitudes that support both present and lifetime learning, and balance teacher-control with personal self-sufficiency in the education environment (Hoese & Casem, 2007).

According to this theory, student constructs their own knowledge from personal experiences, textbook, the teacher explanation or any other means of knowing. In attempting to solve problems on novels, there is perceptual or conceptual similarities between knowledge of a new problem and can remind people of what they already know and the knowledge will be impacted on the learning process. Information not connected with a learner's previous experiences is rapidly forgotten. In short, the learner must actively enrich the existing information by constructing new additional knowledge for meaningful learning to occur. This is due to the fact that constructivism views learning as a process in which the student actively constructs or builds new ideas or concepts based upon current or past knowledge (Jones, Reeds and Weyers, 2003).

2.3 The concept of Specimen Identification, Biological Drawing and Labeling

Specimen identification, drawing and labeling constitute the practical work in senior high school biology. Practical work simply involves the scientific instruction which results in learning activities in science. Student-centered method of doing school work is one of the methods but the flagship for learning in science is laboratory work and by extension Biology (Singer & Hilton, 2005; Lowman, 1995). Woolnough (1994)

stressed that in the laboratory, the assessment of students' behaviors should consist of planning and designing, implementing, analyzing and interpretation of data and application of laboratory techniques to new problems. According to the Macmillan Dictionary (2007), practical is defined as an examination or lesson in which a student makes things or does experiments. Therefore, the term practical refers to what pertains to practice or action, which is "doing". The "doing" aspect will depend on the acquisition of the required skills. Skill can therefore be defined as the capability in doing something. The two terms, practical and skills go hand in hand for the effective learning of specimen identification, drawing and labeling in biology as spelt out in the Biology syllabus.

Practical skills in biology which mainly include the identification of specimen, drawing and labeling are tested completely in the practical paper of all external examinations; however, practical findings may also be tested in a theory paper. Improving the level of competence in student's specimen identification, drawing and labeling skills may determine performances in a class and eventually at the national or a higher level. Going through the materials needed for specimen identification, drawing and labeling, for example those necessary for viewing microscopic organisms, testing for types of food drawing and labeling and doing the specific practical using the provided materials is expected of a student (Roberts, 2004).

Practical works in biology, which mainly include the identification of specimen drawing and labeling allow students handle and observe the materials and specimen they are studying. The identification of specimen by students can be done individually or in groups but drawing and labeling is often done individually, (Namuddu, 1989) and most practical work is done in the laboratory. Emmett (2003) and Twoli, Maundu,

Muindi, Kiio, and Kithinji (2007). Twoli *et al*. (2007) noted that laboratory work is a subset of practical work. Laboratory and practical works however are terms which are used almost interchangeably in natural science. In general, investigational work relies partly on its resemblance to the real thing, creativity in research, and the hope that it will in effect stimulates and fosters the right kind of abilities and ways of thought (Roberts, 2004; Lunetta, Hofstein, and Clough (2007). Researchers and educationists have not agreed finally on the most excellent approach to laboratory teaching and learning for best achievable performance. It is important to contemplate how well practical work can be used in teaching and learning (Jones, Reed & Weyers, 2003 Millar, 2004). Roberts (2004) reported from research findings that, "doing" has been found to be the easiest skill that students can achieve, many students may also perceive to like the "doing" aspect of science practical learning skills but the love may not transform into performance. Hodson (1993), contended that practical center on the doing skills and abilities. Mavhungu (2004) confirmed that practical skills are major teaching and learning strategy that may greatly influence the achievement of learners in Biology. A study conducted by Oyoo (2009) also noted that the practical nature of science, results in solving problems scientifically.

Identification in biology is the process of assigning a pre-existing taxon name to an individual organism. Identification of organisms to individual scientific names (or codes) may be based on individualistic natural body features, experimentally created individual markers (e.g., color dot patterns), or natural individualistic molecular markers which is similar to those used in maternity or paternity identification tests (Waldchen, & Mader 2017). Individual identification is used in ecology, wildlife management and conservation biology. The more common form of identification is the identification of organisms to common names (e. g., "lion") or scientific name (e.

g., "*Panthera leo*"). By necessity this is based on inherited features or “characters" of the sexual organisms, the inheritance forming the basis of defining a class. The features may, e. g., be morphological, anatomical, physiological, behavioral, or molecular. (Osborne & Freyberg, 1985).

Occasionally, the term "determination" may be used as a synonym for identification, or as in "determination slips". Identification methods may be manual or computerized and may involve using identification keys, browsing through fields guide that contain (often illustrated) species accounts, comparing the organism with specimens from natural history collections, or taking images to be analyzed and compared against a pre-trained knowledge base with species information (Wäldchen, *et al* 2017).

2.4 The role of Practical work in the Teaching and Learning of Biology

The argument developed in the previous section, in particular, on the view that much of the scientific knowledge we want to teach in biology is consensually agreed and beyond reasonable dispute. This might be read as implying to a ‘transmission’ view of teaching and learning – that the aim is to ‘transfer’ the knowledge initially in the teacher’s mind into those of the students (Millar 2004).

Where the teaching of abstract ideas are involved, transmission simply does not work. The learner must play an active role in ‘taking on’ the new knowledge. He or she has to ‘make sense’ of the experiences and discourse of the science class and use it to ‘construct meaning’. In this essentially constructivist view of learning, however, the knowledge that we want the students to construct is already known to the teacher throughout. The teaching laboratory is therefore very different from the research laboratory, as Newman (1982) points out:

> *The young child is often thought of as a little scientist exploring the world and discovering the principles of its operation. We often forget that while the scientist is working on the border of human knowledge and is finding out things that nobody yet knows, the child is finding out precisely what everybody already knows. (p. 26)*

Learning Biology at the school level is not the discovery or construction of ideas that are new and unknown. Rather it is making what others already know your own. The difference from a cognitive perspective, is like that between solving a puzzle and having the solution explained to you by someone who already knows it (Millar, 2004). The first might involve pursuing several lines of reasoning and there is no guarantee of eventual success, whereas the second is convergent and with an assured outcome. But there is still cognitive work to be done to grasp it, so as to be able to explain it in turn to someone else or to apply it to new situations.

An implication of this viewpoint is that practical tasks to develop students' scientific knowledge should be seen and judged as acts of communication and not as opportunities for enquiry. The primary criterion which a practical task of this sort should satisfy is that it is an effective means of communicating the idea(s) it is intended to convey. How we might ask and how effectively does it augment other forms of communication (verbal, graphical, pictorial, and symbolic) that teachers might use. Communication' does not simply means acts of 'telling', but the whole range of activities that a teacher plans to encourage and support students as they attempt to construct personal meanings that are more closely aligned with the accepted scientific view (Sandoval, 2003).

Given that the subject matter of science is the material world, it seems natural and rather obvious, that learning Biology should involve seeing, handling and

manipulating real objects and materials and that teaching science will involve acts of 'showing' as well as of 'telling'.

The central question about knowledge and cognition is: how exactly do we (humans) get the world inside our heads? In other words, how do we construct representations of the external world which enable us to live successfully in it and act successfully upon it when we need or wish to? One influential answer to this is provided by the work of Jean Piaget. Piaget argues that, we construct increasingly sophisticated and powerful representations of the world by acting on it in the light of our current understandings and modifying these in the light of the data this generates (Sandoval, 2003).

Through action on the world, we generate sensory data which can either be assimilated into existing schemas or require that these be changed to accommodate the new data, in order to re-establish equilibrium between the internal and external realities. Through such action, we construct a view of the objects that exist in the world, what they are made of and what can be made from them, what they can do and what can be done to them. If Piaget is correct, then practical experience of observing and (even more important) intervening in the world is essential for understanding (Newman, 1982).

The account above may tend to make understanding seem a personal matter – the individual constructing his/her own representations of the world through action on it. Indeed Piaget's view has been criticized on these grounds. In practice, the representations we construct are tested out not only through action, but also through interpersonal interaction. We talk about how we see things, we bounce our ideas off others and have they bounce theirs off us. Our ideas are consolidated where they

agree with others' and challenged where they differ. Through social interaction, our ideas are modified and refined and so are shaped towards a shared set that makes discourse and collaborative action possible.

2.4.1 Accurate biological drawing

The ability to draw, label and annotate biological specimens is an important and useful biological skill. Drawing is a very important skill in biology because it is considered a type of data collection because drawings help to record data from specimens. Drawings can highlight the important features of a specimen. A drawing is the result of a long period of observation at different depths of focus and at different magnifications.

These days' students may well challenge the need for making biological drawings, particularly given the ease of using digital photography for record-keeping. So how can it be justified? The following points help to provide a rationale for developing biological drawing skills: Accurate observation and attention to detail is encouraged (Hoese & Casem, 2007). Having to draw a biological specimen not only increases the amount of time spent examining the specimen, which in itself will aid learning, but requires a much greater level of accurate observation than a casual examination. Active recording aids memory. The educational philosophy behind this is neatly summarized in the well-known Chinese proverb: I hear and I forget I see and I remember I do and I understand.

The drawing provides a permanent record of what has been observed. There is a historic tradition within biology of providing accurate records of specimens so that the images could be used for future reference purposes. Today's taxonomists are often indebted to the illustrators of the 17th and 18th centuries, particularly where the 'type' (reference) specimen may only exist as an illustration.

Even today, when digital photography can be used to store images, artists are still often commissioned to record biological specimens of interest by drawing or painting (Hoese & Casem, 2007). This is particularly true for flowering plants. This is partly because all the features of interest can be combined in one or several scientifically accurate but aesthetic images with great clarity.

2.5 Causes of poor Specimen Identification, Biological Drawings and Labeling among Biology Students

Students encounter difficulties in learning good specimen identification, drawing and labeling skills in biology. The ability to identify biological specimen, make accurate drawings of specimens and label diagrams correctly like any other learning task requires patience and practice (Billiet, 2003). Interpretation and construction of images are core skills students must master in order to understand concepts in Biology and this is not an easy task. Hoese and Casem (2007) and Frith and Law (1995) say that to identify and make a drawing of an object one is looking at, he or she must first convert the information being received with the eyes into a new form that will control the muscles of the hands. The way this information is processed and transformed is best described in cognitive terms.

This is difficult to most learners, especially those with low cognitive level. They added that identification of specimen and drawing depends upon the combination of a number of simple and yet independent processes. What makes a good biological drawing is more complicated than simply its accuracy (Hoese & Casem, 2007). The hardest part of identification and drawing is not as many assume, controlling one's pencil, rather it is the act of observing with precision and consciousness of the specimen before the observer (Amelia, 2007). Amelia continues to say that many

things hinder the act of observation, for example the schemata already in place in the mind of the learner. If the schemata are not in line with what is to be drawn, they have to be altered. The changing of the schemata may be difficult to some students. Another major problem at the present is that Biology textbooks approved by the Ministry of Education are passive on principles of specimen identification, biological drawings and labeling (Sandoval, 2003).

A close analysis of these textbooks reveals that they lack explicit literature on how drawings and labeling are made in Biology. For those which try to shed some light, the literature is scanty and in most cases contradictory and confusing. They also take Biology drawings and labeling to be synonymous with Biology diagrams and in some of the text books the drawings, diagrams and labeling are not based on biological principles. This confusion could be one of the factors contributing to lack of drawing and labeling skills in the majority of secondary school students in Ghana. The following problems are usually encountered in Making Biological Drawings:

i) Making Proportional Drawing

According to Wekesa (2013), students have problems in making proportional drawings. The results he gathered agreed with his findings based on the test he administered in which none of the respondents drew a proportional drawing (figure 2.3). This points to lack of practice in making of biological drawings of specimen and guidance from teachers.

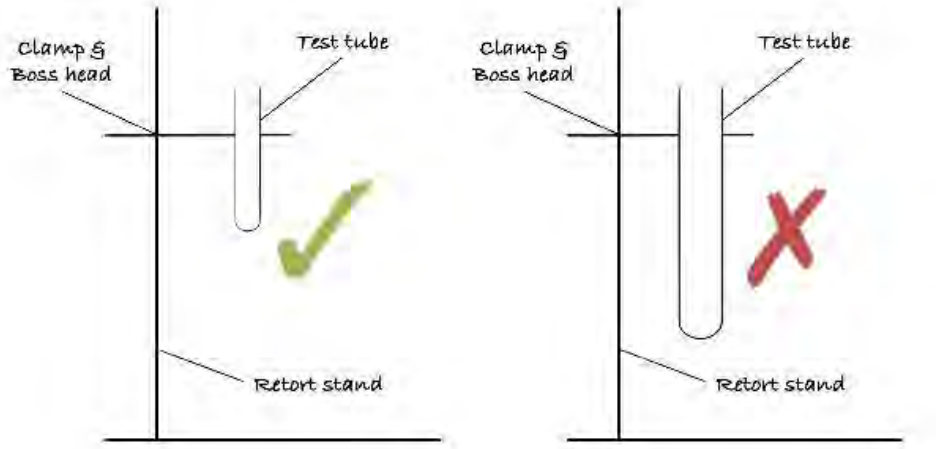

Figure: 2.3: Proportional Drawing

Source: Wekesa (2013)

ii) Drawing Using Free Hand

The proportion of students reported have problems in drawing specimens using free hand, Wekesa (2013). Some of the respondents used a pair of compasses to draw specimens. This leads to incorrect record of information about the specimen.

iii) Making Neat Drawings

One of the main sources of error in students' drawings is untidiness. A large number of students face the problem of making neat drawings Wekesa (2013). A line which encloses a shape, such as a circle, should join up neatly without obvious overlap. Overlapping lines is a common error in hastily drawn sketches and is easily spotted and penalized by examiners (Hoese & Casem, 2007). Untidiness is frequently due to:

- Use of incorrect materials like non recommended pencil, eraser and paper
- Lack of competence in drawing of specimen which leads to unnecessary erasing
- Use unlined paper for the drawing.
- Lack of attention to detail.

The diagrams (Figure 2.4) show a sample of correct and wrong biological drawing made by a student:

Correct **Wrong**

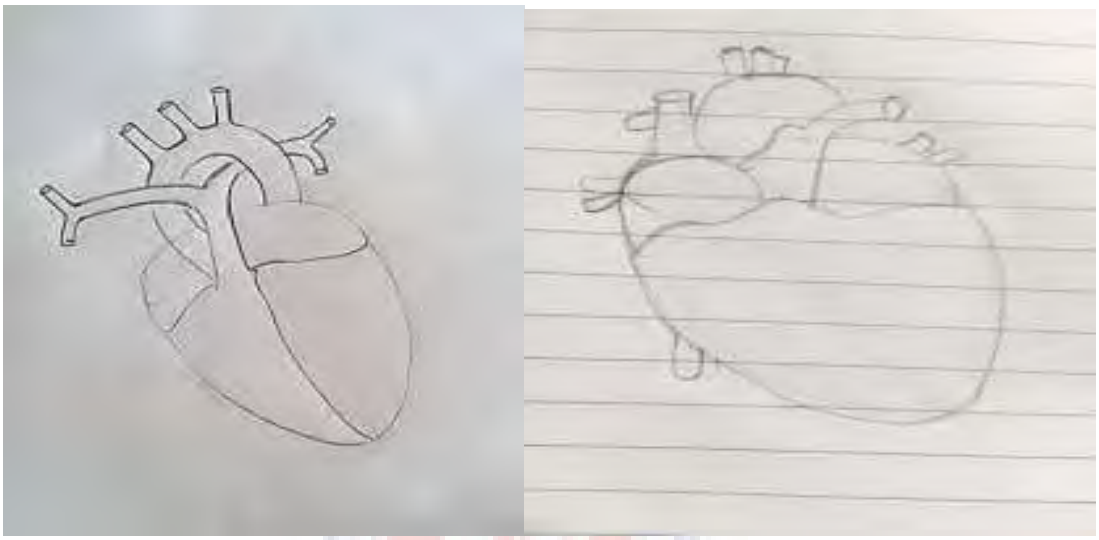

Figure 2.4: Neat Drawings

Sources: Wekesa (2013)

iv) Calculating Magnification

According to Wekesa (2013), majority of the students he sampled in his research could not correctly calculate magnification and were unable to indicate this for the drawings as required. Indication of magnification is important for keeping an accurate record of the organism's size. Lack of the skill could be attributed to lack of practice or negligence on the part of the teacher in inculcating it in the students.

To help in the drawing process it is often useful to use a hand lens or a magnifying glass for larger specimens and for microscopy, both low and high power lenses when making preliminary observations. Field biologists usually carry a hand lens as standard equipment (Sandoval, 2003). Dissection and drawing from a dissection, is

greatly aided by good illumination of the specimen by a lamp and by a tripod lens placed over the material where possible.

It is useful to give an indication of the scale/magnification of a drawing, particularly for large specimens drawn without the aid of a microscope. The actual size of a plant or leaf for example, may be impossible to judge simply from a drawing. For drawings made using microscopes, if the actual scale or magnification is not given, it may be useful simply to indicate whether a low or high power lens was used, preferably the actual magnification achieved by the combined eyepiece and objective lens, usually just below the title.

v. Calculating scale or magnification of a drawing

Scale or magnification, is simply how much bigger or smaller the drawing is compared with the actual specimen. It calculated as follows:

1. Measure between two appropriate points of the drawing (e.g. total length or width).
2. Measure between the same two points of the specimen.
3. Divide measurement 1 by measurement 2.

The diagrams (Figure 2.5) shows a good drawing showing the magnification and bad biological drawing without the magnification:

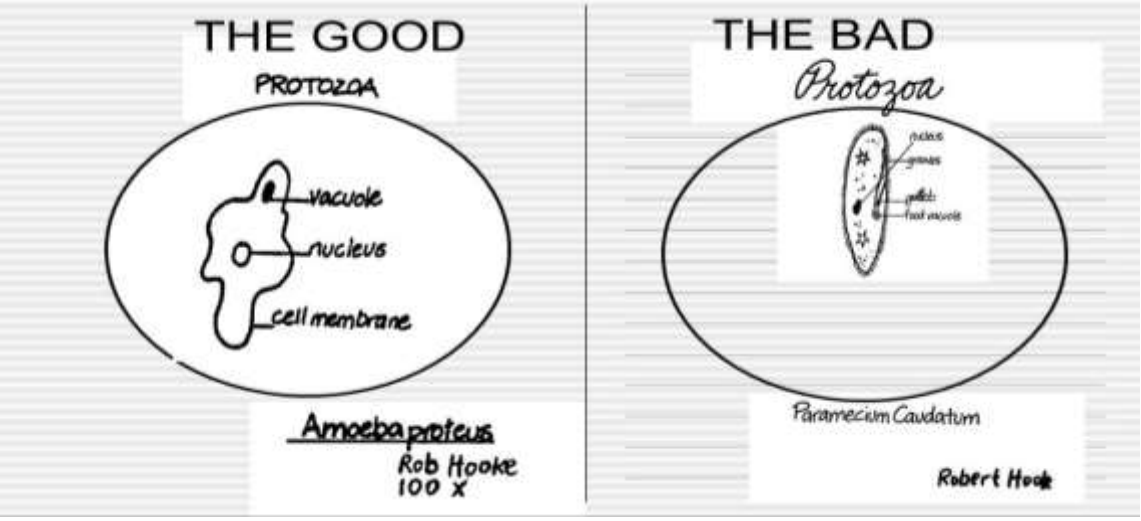

Figure 2.5: Drawing with and without magnification

Source: Drawitneat.blogspot.com (2018)

v) Drawings Continuous Outline

Majority of students have problem in making simple, clear and continuous outline of drawings. Gaps in biological drawings are undesirable. This problem indicates lack of information on how biological drawings are made Wekesa (2013). Accuracy is paramount, it shows good observation. Biology students must remember that observation is assisted by understanding, so a good knowledge of theory goes alongside good drawing (Wekesa 2013). Pay particular attention to the outlines of structures and to the relative proportions of different parts of the specimen. Students must not draw what you think you should see, for example text book style drawings. Draw what you observe.

The diagrams (figure 2.6) show good drawing with a continuous outline and wrong biological drawing with multiple strokes:

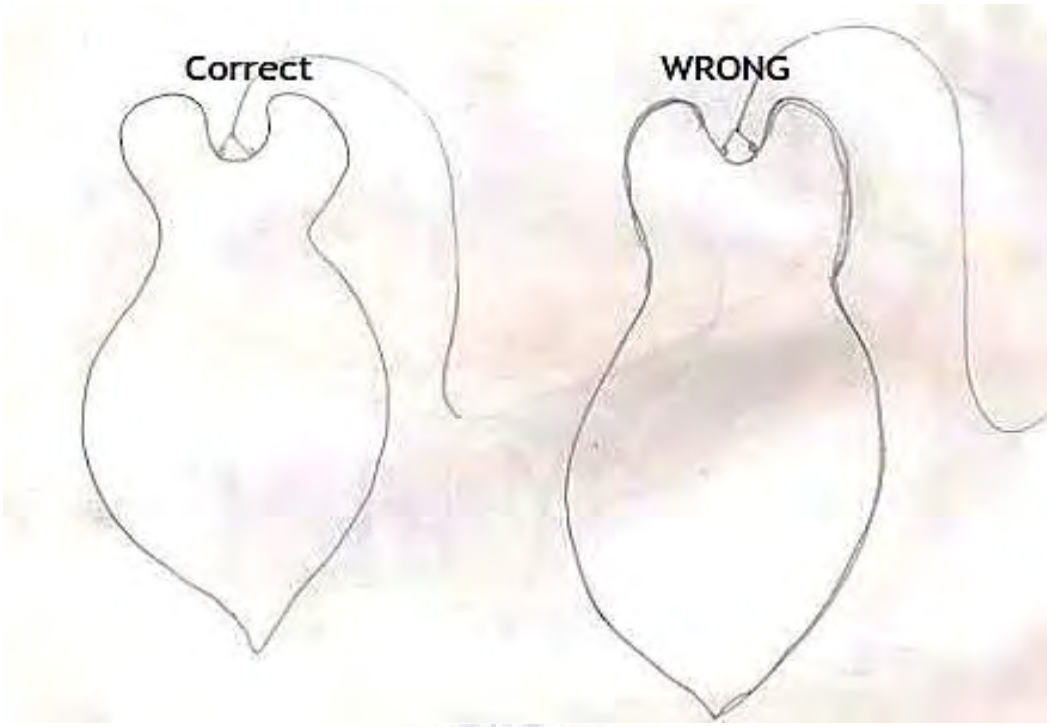

Figure 2.6: Multiple Strokes are Wrong Drawing

Source: Student's exercise (2019)

vi) Indicating the Title of Drawings

Many respondents sampled by Wekesa (2013), in his research did not indicate the titles of their drawings. The title of a biological drawing should be underlined and must indicate the view of the drawing made (Geoff, 2000). This makes future reference to the drawing by other biologists difficult. Negligence to indicating titles to drawings could be due to lack of guidance by the teachers or forgetfulness on the part of the learners. Figure 2.7 shows a student's drawing without a title:

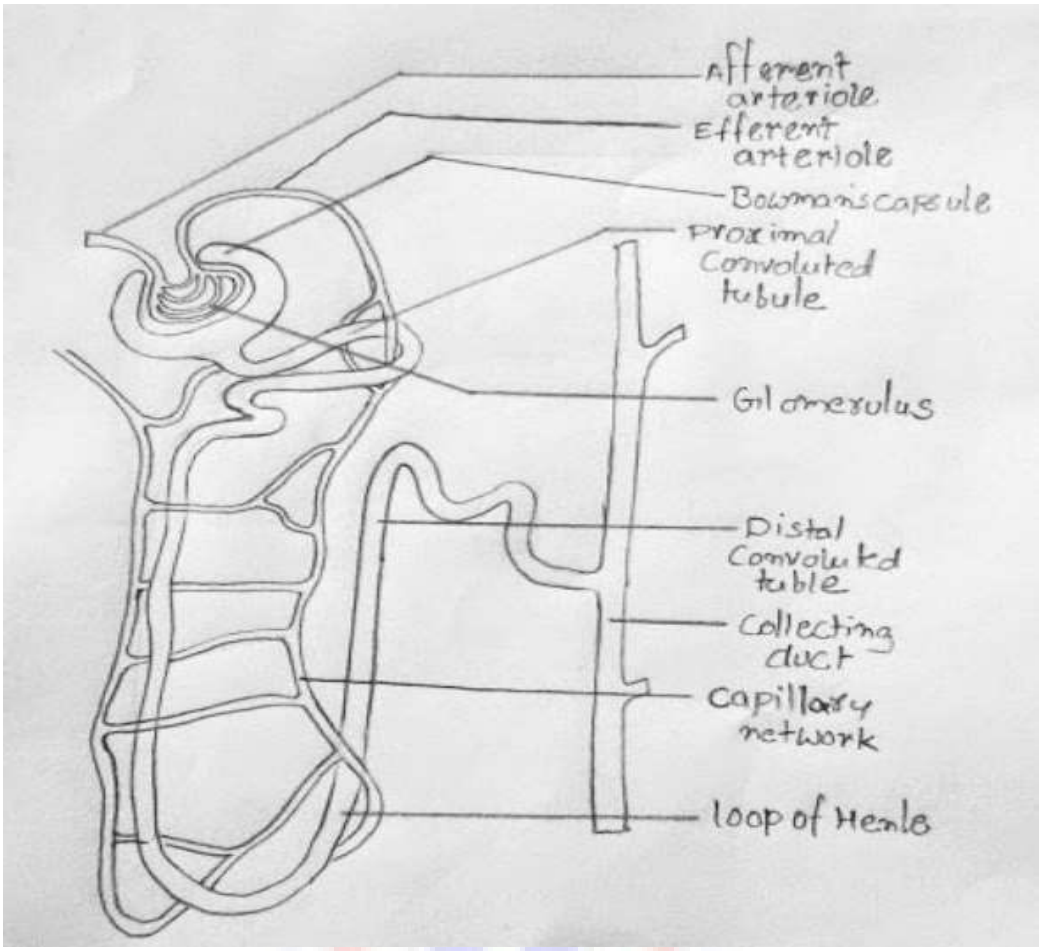

Figure: 2.7: Untitled drawing

Source: Drawitneat.blogspot.com (2018)

vii) Shading of Drawings

Shading in biology drawings obscures some of the structures hence lead to congestion of structure in the drawing apart from making the drawings untidy. This includes stippling, cross-hatching and shading. Students find this is a hard instruction to follow and it is sometimes difficult to justify. Although shading may help to make the drawing look more realistic and or to discriminate between areas of the specimen, it does not represent a permanent structural feature. Artistic impression is certainly not what is required. Figure 2.8 shows a good drawing indicating darker parts with dots and a wrong drawing shading darker parts.

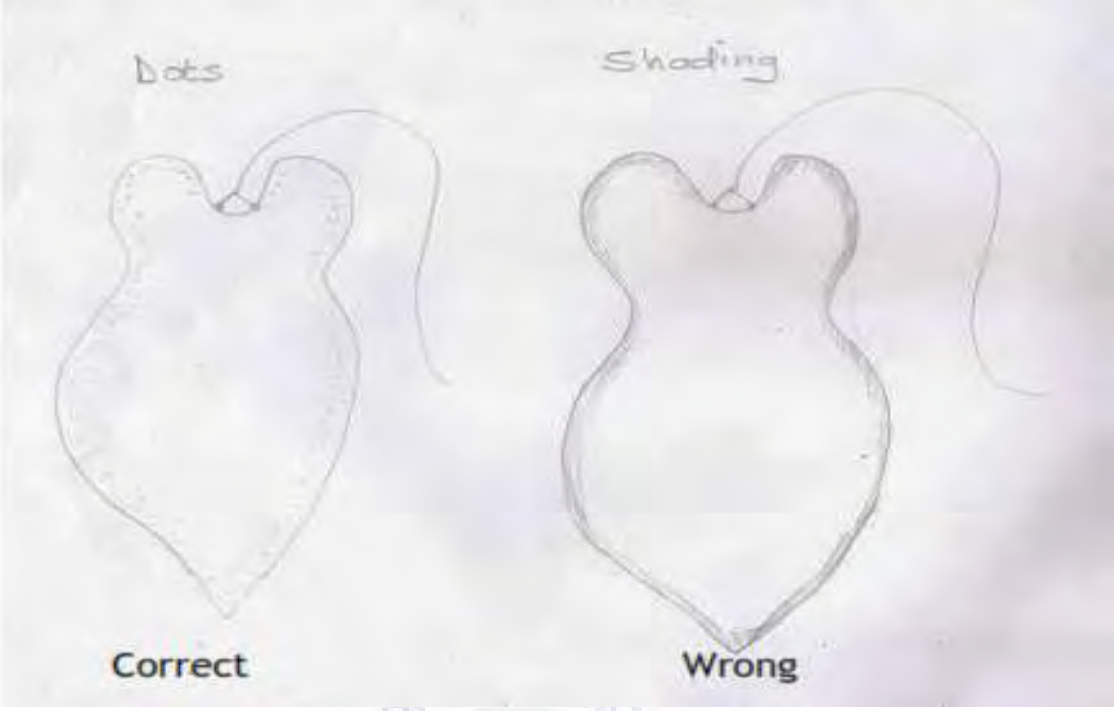

Figure: 2.8: Shading in Biological Drawings

Source: Student's exercise (2019)

viii) Drawing Labeling Lines

Improper drawing of labeling lines makes drawings untidy. Some students draw label lines which cross each other's also uses arrows as labeling lines. Crossing labeling lines and ones which do not touch the structures being labeled, confuse the labels. Arrows normally show directions of flow hence are not to be used as labeling lines. Labeling of biological drawings in an unacceptable way will lead to poor performance in biology. Figures 2.9 and 2.10 are wrong representations of how to draw label lines. Figure 2.9 is wrong because its label lines have arrows. Figure 2.10 is represented wrongly because label line have crossed each other.

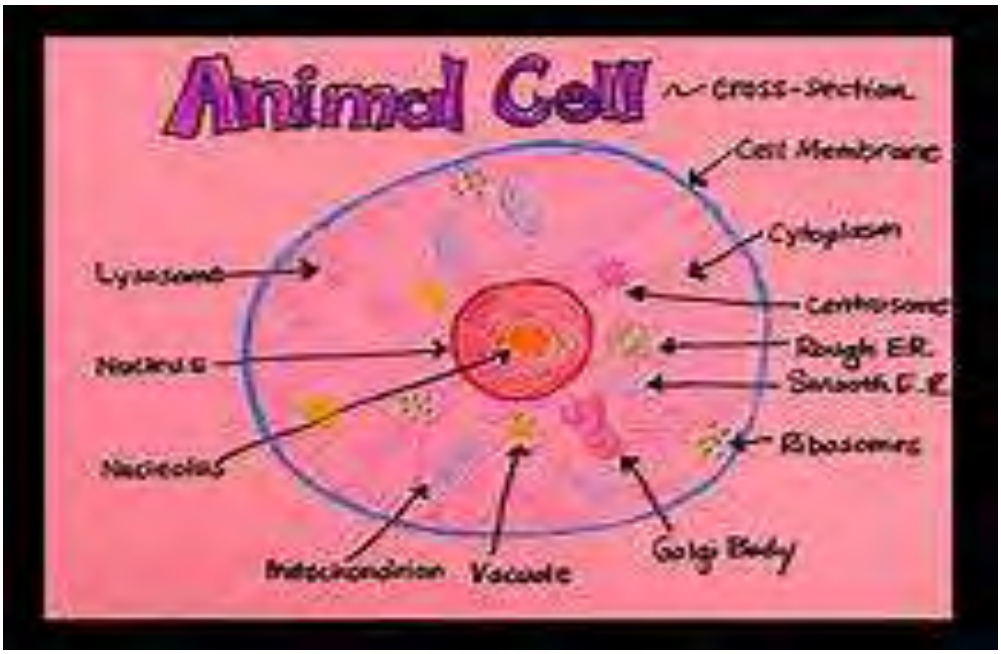

Figure: 2.9: Label lines with arrows

Source: Drawitneat.blogspot.com (2018)

Label lines should not cross each other:

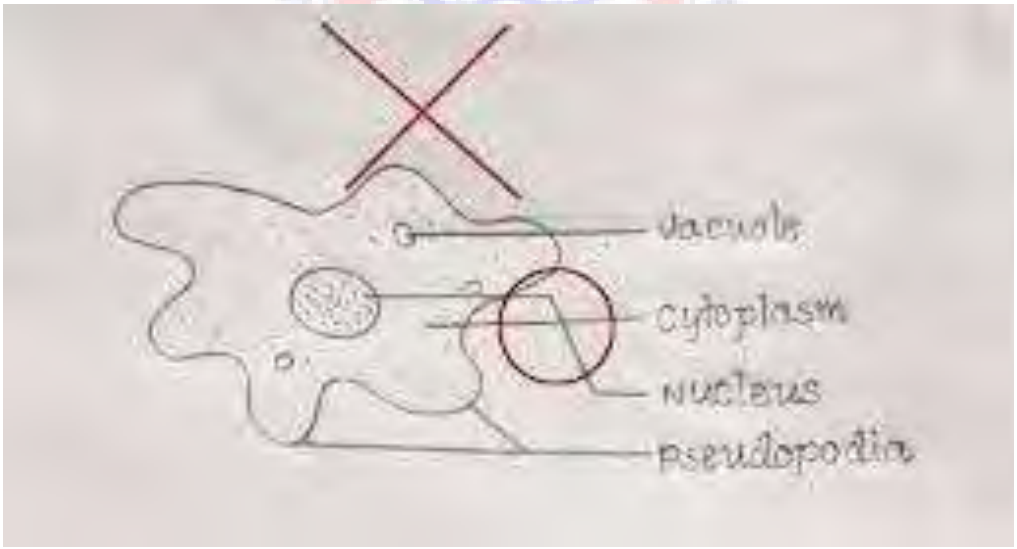

Figure: 2.10: Label lines should not cross each other

Source: Drawitneat.blogspot.com (2018)

ix) Selection of Appropriate Pencil

HB or 2H grade pencils are recommended for making biological drawings. This is because they produce thin; visible outline with uniform thickness. Some students have no idea about the type of pencils recommended for making biological drawings. The use of inappropriate pencil may lead to drawings untidy drawings with unclear outlines. Lack of knowledge in selection of appropriate pencil may be attributed to lack of guidance from teachers.

x) Selection of Appropriate Eraser

Many students have no idea on recommended eraser for correction of mistakes in drawings. The use of low quality erasers will make the drawings untidy, thus lowering the quality of the drawing.

2.6 Unfamiliar Specimens

The same basic principles of drawing technique apply to all drawings and specimens. Nevertheless, it can be daunting for a student if they are asked to draw something they have not seen before or in a new situation, for example a plant growing in a field, a fungal colony growing on an agar plate or an unfamiliar slide. Assessment questions will always be phrased so that it is clear exactly what is required and any relevant information the student is not expected to know will be provided. The important thing to remember is to follow instructions carefully and to observe and draw the actual specimen and not try to guess what should be visible. For example, roots should not be drawn on a plant growing in the field if they are not visible.

Specimens should be studied carefully before any drawing is undertaken, noting particularly where the outlines of structures are going to be delimited in the final

drawing. Depending on the subject, separate, more detailed drawings may be useful to highlight features of particular biological interest.

2.7 Rules for Biological Drawings

1. Draw what you see, not what you think should be there.
2. A lead pencil, preferably a 2H is to be used for drawings, titles and labels.
3. Drawings (or diagrams) should be as simple as possible with clean cut lines (do not sketch) showing what has been observed. All drawings should be done on unlined (blank) paper and should be also neatly labeled.
4. Drawings must be large enough to show all parts without crowding. The greater the number of parts to be included, the larger the drawing should be. Drawings must be about half a page in size.
5. Keep your drawing to the left of the Centre of the page. (Save the right-hand side of the page for labels)
6. All labels should be in a column to the right of the drawing and printed. Lines to the labeled parts should be drawn with a ruler and parallel to each other. The lettering of the words should be horizontal.
7. Use a ruler for label lines.
8. Do not shade your drawing. If you wish to indicate a darker area use dots (stipple).
9. Indicate the thickness of a plant cell wall by using 2 lines.
10. Most plant and animal tissues are made up of individual cells. When one representative cell of such a tissue is to be drawn, make sure you include the cell boundaries of the other cells that border it. This will indicate the general appearance of the tissue without the necessity of drawing every cell.

11. All drawings are titled. The printed and underlined title appears immediately above the drawing, against the left-hand margin. The magnification of the object drawn follows the title and is in parentheses. Example: Blood Cell (300X).
12. Name and date are printed in the top right hand corner.

2.8 Computer -Assisted Instruction (CAI)

Computer- Assisted Instruction (CAI) is a program with instructional material presented by means of a computer or computer systems. Drill and practice software is generally called Computer-Assisted Instruction (Jurich, 2001; & Cotton, 2001). Computer-assisted instruction (CAI) is that in which teacher use computers at different times and spaces according to the characteristics of the subject matter, the students and the available software and hardware. Most recent CAI software integrates features that encourage activities beyond the simple drill-and-practice, such as simulations, graphing and even modeling (Kara, & Yesilyurt, 2007; Jurich, 2001 & Barot, 2009).

According to Andrews and Collins (1993), CAI is tutorials (drill and practice — response oriented interaction), problem solving (laboratory and lecture exercises), simulation exercises (in lecture or laboratory settings), enrichment programs, remedial learning (continuous and repetitive), games (applications of problems or concepts) and testing (test banks with evaluation and analysis). According to Barot (2009), computer provides immediate feedback letting students know of their achievement.

2.8.1 Development of CAI

- ***Identify Problem area***: Select the Unit area where students are having problems and there is really a requirement to develop CAI.
- ***Design Specific Objectives:*** After identifying the problem, design objectives related to the problem.
- ***Develop CAI Programme:*** After completion of the program material, it should be programmed through the Computer Software for converting it into CAI. Different software used is Microsoft office Flash, Corel Draw, Page Maker and many other graphical software. Most commonly used software is YouTube and PowerPoint. For the first time, teachers can easily modify and even produce their own CAI material based on the needs of their own classes. (Khirwadkar, 1998; Ranade, 2001; Andrews & Collins; 1993 and Barot, 2009).

2.8.2 Benefits of effective use of CAI

1. Self-paced learning opportunities: Learner can learn the content as per his or her capacity and can repeat the task if the learner does not understand (Barot, 2009; Cotton, 2001).
2. Immediate feedback to the student and the instructor: Immediate feedback motivate learners and give direction and if answer of students is wrong then it will help him to correct his mistake (Barot, 2009; Khirwadkar, 1998).
3. Automatic adjustment to ability levels of students: CAI programs are designed in such a way that it helps both brilliant students as well as slow learners. It is flexible as per user‘s need (Andrews & Collins, 1993; Barot, 2009; Ranade, 2001).

4. Continuous interaction: Continuous interaction should be possible with CAI. (Khirwadkar, 1998; Barot, 2009).
5. Flexible time scheduling for the students and the instruction: Programmes have flexibility in terms of time, place and pace (Barot, 2009; Ranade, 2001; Kara, & Yesilyurt 2007; Cotton, 2001).

2.8.3 CAI in Biology

Costa, Galembeck, Marson, and Torres (2008), worked on a quick guide for Computer-Assisted Instruction in Computational Biology and Bioinformatics and gave the following guidelines:

- Ensure that CAI activities are integrated into the curriculum.
- Do not overuse CAI
- Plan for use of CAI well-adjusted to Infrastructure and Resources available • Maximize interactivity
- Allow different rates of progression in class, but ensure that all students reach the objectives. Ensure students understand the scope and objectives of assignments.
- Be sure students understand the models presented on the screen.
- Assess and evaluate students' performance while using CAI

A computer enables repeated trials of experiments with considerable ease in a limited time, provides immediate feedback, allow stimulus, observation of graphical representation and offers a flexible environment that enable students to proceed with their own plans (Ahmed, 2009; Kara *et al*, 2007; Andrews & Collins 1993). Studies carried out by researchers on the use of computer -assisted instruction in biology found that most of the students of secondary and higher school levels have problems

in the molecular biology and in the area of genetics. CAI is very helpful to minimize such problems. (Kara *et al* 2007 and Ahmed, 2009).

Arthur, Abaidoo, and Arkorful (2019), settled that, the usage of CAI to supplement traditional way of teaching produces greater success than the use of traditional method of delivering an instruction. Ongoing research is indecisive concerning comparing the effectiveness of using only the traditional method of instruction and CAI only and that computer-based education produce higher achievement than the traditional way of instruction alone. Additionally, students absorb instructional contents faster with CAI than with traditional method only, they are able to keep what they have learned better with CAI than with traditional way of instruction alone. Moreover, computer- assisted instruction has been found to boost students' performance than the conventional instructional method.

There have been a lot of research on Computer- Based Instruction (CBI) and diverse results have been attained in different studies. It was revealed in some of these studies that CBI helps to create more effective learning situations than traditional method of teaching. Some of these traditional methods of teaching involves discussions, teacher presentation, question and answer techniques, etc. It has also been establish that CBI serves to develop meta-cognitive skills in learners and helps them to absorb content in a meaningful manner instead of rote-memory learning and also enables them to increase their achievement. (Atta, 2015).

According to Bayraktar (2001), there is no significant difference between the CBI and traditional teaching methods This study, which aims to test the impact of the use of the CBI, was thought to be important as it would contributed to the wide use of

educational software which triggers active participation and enables students to make their own meaning.

2.8.4 Problems in teaching of Biology

After reviewing studies of Ranade (2001), Kara and Yesilyurt (2007) and Andrews and Collins (1993), it was elucidated that Biology subject has the following major problem areas that cause ineffective learning:

1. Students have serious misunderstanding about biochemical and genetics concepts, even concerning the basic scientific content related to biological inherence.
2. Students face problems in genetics terminology, students may get confused because terms look and sound very similar.
3. Sometime students do not understand the concept due to ineffective teaching in the classroom. In Indian classroom, most of the teachers adopt lecture methods. But concept of genetics and biochemistry are not easily understood by lecture method.
4. Many teachers are not adept at using quick sketches to explain certain content or in drawing diagram. Some do not possess a big enough knowledge-base to link scientific content with day to day life example.

After reviewing different research studies of Kara and Yesilyurt (2007), Jurich (2001), and Barot (2009) on Computer- Assisted Instruction. The researcher mentioned the following recommendations:

1. CAI provides students with broad understanding of Biology and its utilization in real life.

2. CAI familiarizes students with range of concept application in all walks of life and the computers' potential as a controlling tool.
3. CAI should be introduced at the Higher Secondary level at the outset to be followed by the Computer literacy at Secondary and primary school levels.
4. Computer Education should be the part of school curriculum.
5. Computer literacy programme would enable student to become familiar with Computer and its potential as a versatile tool with application in all aspects of human endeavors.

Students are not ready to take biology because biology has so many branches and require lots of potential to do the things. To overcome such types of problems computer- assisted instruction software packages and developed programmes can be used and different videos related to content is easily available on the internet.

2.9 What is YouTube?

YouTube is a social media platform that was launched in 2005 that allows billions of individuals to discover, watch and share original user created videos (YouTube, 2015). This platform provides a forum to connect, inform and inspire individuals across the world. This research study aims to understand how educators are using YouTube in their practices. It is important to understand how YouTube is being used, as video is a powerful educational and motivational tool that is being used in the classroom today (Duffy, 2007). The power YouTube has as an educational tool depends on how it is integrated into classroom learning (Duffy, 2007), which this research study aims to understand. By understanding how educators use YouTube as an educational tool, specific strategies can be identified and recommendations for integration can be made to maximize this potential.

2.9.1 m-Learning and YouTube

The concept of mLearning describes the learning that occurs through the use of a small, personal device. It is defined as learning that is personal and connected through the use of a mobile device (Romrell, Kidder, & Wood, 2014). Mobile devices are at the center of mLearning, which includes phones, smart phones, tablets and even small laptop computers (Romrell, Kidder, & Wood, 2014). With the exception of a desktop computer and smart board, this encompasses most of the technological devices that are found in the 21st century classroom. All of these devices can be used to view YouTube videos for either educational or personal purposes.

The researchers Romrell, Kidder and Wood (2014), present two specific characteristics that define mLearning. The devices used are individualized, meaning they show the students unique choice in device, accessories, applications and even colour and font styles.

Secondly, the devices are also connected. This connection is instant and it allows the students easy access to the Internet, videos, phone calls, instant messaging and more. mLearning illustrates the flexible nature of how YouTube can be used in the classroom as it can be accessed through small, mobile devices such as personal smart phones, tablets and small lap top computers. For mLearning to be maximally effective, it is helpful if these devices belong to the students, as they will be more comfortable and fluent in their use. With some schools implementing programmes such as Bring Your Own Device (BYOD), students can now use their own smart phones, tablets and laptops in the classroom. YouTube is compatible with any of these devices, making it an accessible tool. YouTube can also be made personal, as students

can sign in with their school or personal, enabled g-mail accounts and they can customize the account to their needs.

When using YouTube on a mobile device, it is also connected through Internet or cell phone reception and videos can be shared amongst users in a variety of ways. YouTube allows the user to share videos through their share function and allows for users to comment and be a part of an online discussion. Using mobile devices to access YouTube is an example of how mLearning can be achieved. There are some aspects of mLearning that educators need to be conscious of when teaching with such technology. When using YouTube, educators need to be aware of the content that students are accessing on their devices inside the classroom. Since the students are using their own devices, measures need to be put in place to make sure they are using applications appropriately. When connecting online, educators need to make sure all communication is monitored and geared towards content being discussed in class. Using the Technological Pedagogical Content Knowledge (TPACK) framework, as YouTube was not initially created as an educational tool, educators need to adapt and find ways to safely implement it into their teaching practices.

2.9.2 TPACK and YouTube

Technological Pedagogical Content Knowledge (TPACK) is a framework that combines the three kinds of knowledge needed to use technology effectively in the classroom. There are three knowledge components that comprise TPACK; technology, pedagogy and content (Koehler, Mishra, Akcaoglu, & Rosenberg, 2013). It is the interaction between these three areas of knowledge that allow for technology to be used to its best capacity to allow for ideal levels of learning to occur.

Introducing technology in the classroom is complex as it is always changing. This means that the teacher's knowledge and ability to use this medium is always going to change and impact their pedagogy and in turn their delivery of content knowledge. The TPACK framework is important because it acknowledges this complexity as it identifies a unifying structure that provides guidance and support for technology integration (Koehler, Mishra, Akcaoglu, & Rosenberg, 2013). To further understand this framework, the three areas of knowledge need to be further discussed.

Technological Knowledge includes knowing how to use the technology in an educational setting and being able to adapt to new forms of technology. Pedagogical Knowledge is understood as the 'general purpose' knowledge that is specific to teaching. It is the skills that teachers develop over time to be able to manage and organize teaching to reach learning goals and specified outcomes (Koehler, Mishra, Akcaoglu, & Rosenberg, 2013). Content Knowledge targets the specific content or subject that is being taught. To bring these three components together, TPACK focuses on how technology can be used to meet pedagogical needs while effectively teaching content (Koehler, Mishra, Akcaoglu, Rosenberg, 2013).

TPACK is a framework that can help educators make the process of navigating YouTube less complicated, and give them a strong foundation for turning YouTube into an effective educational tool. In order to have the most effective integration, all three knowledge bases need to come together. This can be difficult as technology is always changing and there is always something new to learn and master. The choice of technology impacts the pedagogy and impacts the content that is being taught.

This section discusses about what YouTube looks like and how it can be used for teaching. If a teacher decides to use it in class, it may be helpful to know some basics.

Wikipedia says: “YouTube is a video sharing website on which users can upload and share videos and view them in MPEG-4 format." (http://en.wikipedia. org/ wiki/Youtube). In other words, it is a website where you can find all sorts of videos which people have made of themselves, others, of TV shows, etc. and have put on the web for everyone to see. The easiest way to experience the variety of videos is to visit the website yourself. Just click on the following link: http://www.youtube.com/.

2.9.3 Significance of using YouTube in my classroom

You Tube is very significant because you can use it in face-to-face and online teaching and learning environments. For instance, you can find a video you like and show it to your class using your computer and an LCD projector or a DVD player and a TV. Because it is a relatively simple way of bringing authentic audiovisual material into the classroom. It is just a matter of finding an appropriate video, making one yourself, or having your students make one. Because the authenticity of the material and communicative situations presented on YouTube videos allow to work on both language and culture. For instance, you may find a video of a real-life situation in the target culture (e.g. a video of someone riding in a London taxi cab and talking to the driver). Because it appeals to the students – usually it’s part of their world. For instance, your students may already be sharing or watching videos using YouTube – you just have to capitalize on that. Because it gives you more possibilities – it appeals to different learner types (audio, visual, learning by doing). Because it allows students and teachers to bring material to the class, that is shared responsibility. Because it facilitates a task-based approach to learning: allows student to learn the language while creating documents and audiovisual material that they can put on YouTube. Just like with any other classroom material, you need to keep the pedagogical considerations in mind (e.g. learning objectives, authenticity, speech rate, etc).

2.9.4 A guide through some basic features of YouTube

To visit the site, just click on the following link: http://www.youtube.com/. Four basic features are explained here:

- The welcome screen
- Playing a video
- Searching for a video
- How can I find appropriate material?

The welcome screen

When the website opens, you will see a screen that is similar to this one:

Figure 2.11: YouTube welcome screen

Source: YouTube 2018

Each of the framed pictures is a link to a video. Next to each video there is some information on it:

- its name (*Biological drawings*),
- how many times it was viewed (*1,582,449 views*),
- how long ago it was uploaded (put on the web) (*5 months ago*)

Figure 2.12: YouTube selection screen

Source: YouTube 2018

In the right bottom corner of each frame you can also see a number, which shows the length of the video in minutes and seconds (*3:41*).

2.9.5 Playing a video

When you click on any of the pictures in the frames, the video you clicked will open. For instance, this is what happens when I clicked on the *Biological drawing format* video:

Figure 2.13: YouTube video screen 1

Source: YouTube, 2018

Depending on how fast your internet connection is and the length of the video, it may take some time before you can watch it. Please note that watching videos on YouTube works best if you have a relatively fast Internet connection. No need to despair, though: once the entire video is loaded, you should be able to watch it again without your feedback being choppy. The video may start automatically and if it does not, you can click on the play button in the left bottom corner.

2.9.6 Searching for a video

Finally, you can search for a video. Just enter some keywords in the search window on the top of the page. When you type the appropriate keywords it is sometimes

helpful to use the search suggestions. For instance, in the following example we used the search term "Blackadder" – as soon as "blackad" was typed in, some suggestions appeared.

Figure 2.14: YouTube video screen 2

Source: YouTube, 2018

You can finish typing the keyword that you want (because the suggestion may not be the word you were looking for) or you may choose one of the suggestions. Click the search button or just press enter on your keyboard and you will get a list of videos that are connected with this search term: Then, you can just click on one of the videos to watch it.

Figure 2.15: YouTube video screen 3

Source: YouTube, 2018

2.9.7 How to find appropriate material

Open YouTube (http://www.youtube.com/) and use the search function. Use keywords to search for videos. When you type the appropriate keywords it is sometimes helpful to use the search suggestions:

Figure 2.16: YouTube video screen 4

Source: YouTube, 2018

Go through the material to see whether it fits your purpose. To help you in your selection, you can use the information available underneath the video, such as the number of people who watched the video (*51,680*), the length (*6:42*) or even the rating (the number of likes and dislikes: 81 likes and 4 dislikes for this video).

2.9.8 Strategies for Using YouTube

The existing literature provides insight for ways to optimize the use of YouTube as an educational tool in the classroom. Bonk (2008), conducted a survey of over 1000 participants and found that short videos between one and four minutes' are ideal when used for teaching purposes. Bonk found that videos that are informative, humorous, current, interesting and engaging are most preferred by students (Bonk, 2008). The survey revealed that most people do not create videos or comment on YouTube

videos, but they do watch and share them on a regular basis. Bonk (2008) recommends that instructors choose a video based on its instructional value, not simply due to its humorous content. A few drawbacks were mentioned, specifically regarding the technical side of showing a YouTube video.

When using YouTube, some problems may not be evident until the time comes to play the video such as the video being taken down without any notice or network settings such as firewalls that restrict the video from being played in a certain location (Bonk, 2008). It is recommended educators have a backup plan, including downloading or converting the video to be played without Internet access (Bonk, 2008). Copyright and online content protocols can be elaborate, confusing and difficult to understand as they differ from each school board. It is important for educators to be informed about these policies and how they need to be aware of their actions. This study provides practical insight and strategies for using YouTube for instructional purposes.

The article 'Engaging the YouTube Google-Eyed Generation: Strategies for using Web 2.0 in Teaching and Learning' by Duffy (2007), provides several strategies for using video technology in the classroom. The main idea was that video learning should not be passive, rather it needs to have a purpose. Several guidelines were developed to promote active viewing and maximize student learning. Duffy (2007) recommends that videos be played in short segments, allowing students to ask questions or to think critically about the content they just viewed. Students should also be encouraged to take notes while watching videos. Videos are ideal for developing note taking skills, which can be done by taking notes on the first viewing and then replaying and checking the notes (Duffy, 2007). Utilizing the 'pause'

function on video is a great way to allow the students to predict what might happen or to recall the information from the video. Another strategy that Duffy (2007) suggested, is playing the video with the sound off, this allows the students to focus on the visuals of the video and for the instructor to narrate.

Lastly, it is vital for the students to be given responsibility when viewing a video. The instructor needs to introduce the video with a question or instructions, such as telling the students to look for unfamiliar vocabulary. The video should also have an activity to go along with it to make the content clearer and meaningful (Duffy, 2007). This keeps the students on task and it aims to reach the learning goals and objectives of the lesson. Instructors should also follow up after the video is done with questioning. Duffy (2007) offers practical advice and strategies for using video technology in the classroom, all of which can be implemented when using YouTube.

An article titled 'YouTube: Educational Potentials and Pitfalls' by Cuthrell & Jones (2011), is a literature review that discusses the potential and the challenges of using YouTube in the classroom. The researchers offered several suggestions for overcoming these challenges. The researchers stated that YouTube has the potential to be used for more non- traditional subjects, such as math to enhance student learning in an innovative way (Cuthrell & Jones, 2011). The researchers highlighted that YouTube has the potential to introduce new concepts, disseminate information and close lessons (Cuthrell & Jones, 2011). Some of the pitfalls the researchers found include the need for teachers to be cautious when selecting materials to ensure they are credible, accurate and meaningfully support their teaching content (Cuthrell & Jones, 2011). This relates to educators' abilities to utilize this resource effectively, which includes selecting suitable material to present to the class. Another challenge of

YouTube presented by the researchers is that it can sometimes be unreliable as videos may be taken down or are difficult to find (Cuthrell & Jones, 2011). This relates to Bonk (2008)'s point about always having a backup plan in case the video is no longer available when the lesson begins. Thus, YouTube can serve educators and assist with limiting such pitfalls by providing tools that allow teachers to assign videos to an accessible playlist and utilizing subscriptions to ensure that a quality video is always accessible.

2.10 Empirical Studies on Computer- Assisted Teaching

Several studies were conducted on the use of computer in teaching at the various levels of education. Some of these studies and the results are presented below:

Empirical Studies 1

Jeyamani (1991) conducted a research on effectiveness of simulation model of teaching through Computer- Assisted Instruction from Avinashilingam Institute of Home Science and Higher Education for Women, Coimbatore as a part of MPhil degree. This study was guided by the following objectives:

(i) To find the effectiveness of the simulation model of teaching as compared to the traditional method.

(ii) To utilize the growing use of computer in education.

The findings of the study included:

(i) The experimental group obtained a higher mean than the control group.

(ii) The sex wise comparison provides to be insignificant.

(iii) There was no significant difference in learning level between Tamil medium and English medium students.

(iv) On the basis of the research findings it was concluded that the experimental group performed significantly better than the control group.

Empirical Studies 2

The study compared the effectiveness of Computer-Assisted Instruction (CAI) as compared to lecture method on the topics Tissues and cells.

The findings of this study were:

(i) Both methods were effective in enhancing the learning about cell and tissues.

(ii) While lecture method was more effective than CAI for the teaching cell, CAI was more effective than lecture method for teaching tissues. Dange & Wahb, (2006).

Empirical Studies 3

Singh, Ahluwalia, and Verma, (1991) conducted a research on the Effectiveness of Computer -Assisted Instruction (CAI) and Conventional method of instruction. The study centers upon the problem of the effectiveness of Computer- Assisted Instruction and of the conventional method of instruction in teaching mathematics, in terms of achievement of mathematics and direction of change in attitude towards mathematics of male and female students.

Objectives that guided the study were:

(i) To study the difference in mathematics achievement which occurs as a result of the difference in instructional strategy among boys and girls separately and as a group.

(ii) To study the direction of change in attitudes of male and female students separately and as a group towards mathematics as a result of two different instructional strategies. The sample of the study consisted of 220 students from four selected higher secondary schools, covering the good, average and poor schools of the Bhilai steel plant, Bhilai (M.P.).

The following findings were obtained:

(i) The students who used the computer scored significantly higher than that taught mathematics through the conventional method.

(ii) The students who used the computer showed significantly highly favorable attitude towards mathematics than those who did not use the computer

(iii) Achievement in mathematics and change in attitude towards mathematics were found to be independent of the sex factor Gilman and Brantley (1988).

2.10.1 YouTube and the Traditional Classroom

In Wu and Chen (2008)'s case study titled 'Basic School Teachers Use of Instructional Material on the Web', the researchers sought to answer the question on how school teachers navigate online instructional materials?' Their research is relatively current, which is essential as technology is constantly changing and becomes obsolete in a few years, outdating the research. Their finding showed that all teachers used the Internet before designing their instructional activities. The teachers have two main reasons for using the Internet, one is to refer to other teacher's materials and the other is to obtain up-to-date information materials such as photos and videos (Wu & Chen, 2008). These findings indicate that videos are very popular for teachers when they are planning for their lessons. Wu & Chen (2008) reveal that

the participants thought it was necessary to have 'true life information' such as videos because it stimulates the classroom and it makes it more interesting (Wu & Chen, 2008).

Half of the teachers interviewed stated that they spend less than one hour searching the Internet and that if they cannot find what they were looking for in 10 minutes they turn to other sources. One participant specifically stated that it takes too long to search through results to find good materials (Wu & Chen, 2008). This demonstrates that there is a need for teachers to have better indexing and archives of such resources. It also shows that video materials are a popular element of teacher planning. Video sharing websites, specifically YouTube, have features that can be used to make this process easier.

A research- based study by Zahn, Krauskopf, Hesse and Pea (2010), Investigated pedagogical knowledge among German pre-service teachers in relation to their mental models of YouTube and how it affects lesson planning. Their main research question was 'how can teachers overcome the sub-optimal pedagogical practices for video usage and support learning instead?' They stated that teachers constructed or activated mental models of video technology, which become an important factor in their cognition for planning the use of video in class. Zahn *et al.* (2010) described mental models as representations of situations and interrelations that people construct based on their prior knowledge and beliefs (Zahn *et al.* 2010). The researchers reference TPACK and integrating these three aspects of professional knowledge assisted the complex task of teaching content with technology (Zahn *et al*. 2010). To further understand the problem, they administered a questionnaire online to a forum of 60 pre-service teachers in Germany, asking them about their intended uses for YouTube

in the classroom, barriers they have encountered and how they integrated YouTube into their lesson plans. The results showed that the intended uses of YouTube in the classroom were for teacher presentation, information repository and content elaboration (Zahn *et al* 2010). The survey also revealed that the teachers focused on YouTube as a visual medium and a searchable database (Zahn *et al* 2010). There is a need to further understand YouTube as a searchable database and how it is facilitated in the classroom, and how teachers monitor the use of such database. (Hesse, & Pea (2010).

CHAPTER THREE

METHODOLOGY

3.0 Overview

In this chapter, the methodology of the study have been discussed. The research design which is in two phases, described how the researcher conducted the research. The initial phase was the collection of data on the learning difficulties of Biology students in specimen identification, biological drawing and labeling in the Senior High School through questionnaires from the students, observation and interview. The population of the study was made up of all biology students in Winneba Senior High Schools in the Effutu Municipality, but only 35 was sampled for the study. The questionnaires surveyed biology students' opinions about the learning difficulties of Biology in identification of specimen, biological drawing and labeling. This was pilot tested and later fine-tuned to establish its reliability. Finally, the data collected was analyzed using the mixed method (quantitative and qualitatively) to establish the learning difficulties of Biology students in specimen identification, biological drawing and labeling in the senior high school.

3.1 Research Approaches and Design

The study adopted the action research design and the mixed method approach to data collection. For Creswell (2007), exploratory research is the initial research into a hypothetical or theoretical idea. This is where a researcher has an idea or has observed something and seeks to understand more about it. An action research project is an attempt to lay the groundwork that will lead to future studies, or to determine if what is being observed might be improved by an intervention. Most often, action research lays the initial groundwork for future research.

Both quantitative and qualitative research methods were adopted to address the problem.

Quantitatively, students' marks obtained in both the pre-test and post-test were recorded over ten. Students were given codes from **W1** to **W35** to secure their identity.

According to Creswell (2007), using both quantitative and qualitative designs allow the researcher to explore a complex social or human problem, builds a complex holistic picture, analyses words, reports detailed views of informants and conducts the study in a natural setting.

3.2 The Study Area

The study was conducted in Winneba Senior High School in the Effutu Municipality. Winneba is the capital of Effutu Municipality. It is a town where more importance is given to education. The town has the University of Education, Winneba, one Community Health Nurses Training School, one public Senior High School and three private Senior High Schools, vocational schools and numerous Junior High and Primary Schools. Because of this, many people travel near and far to be educated in the town.

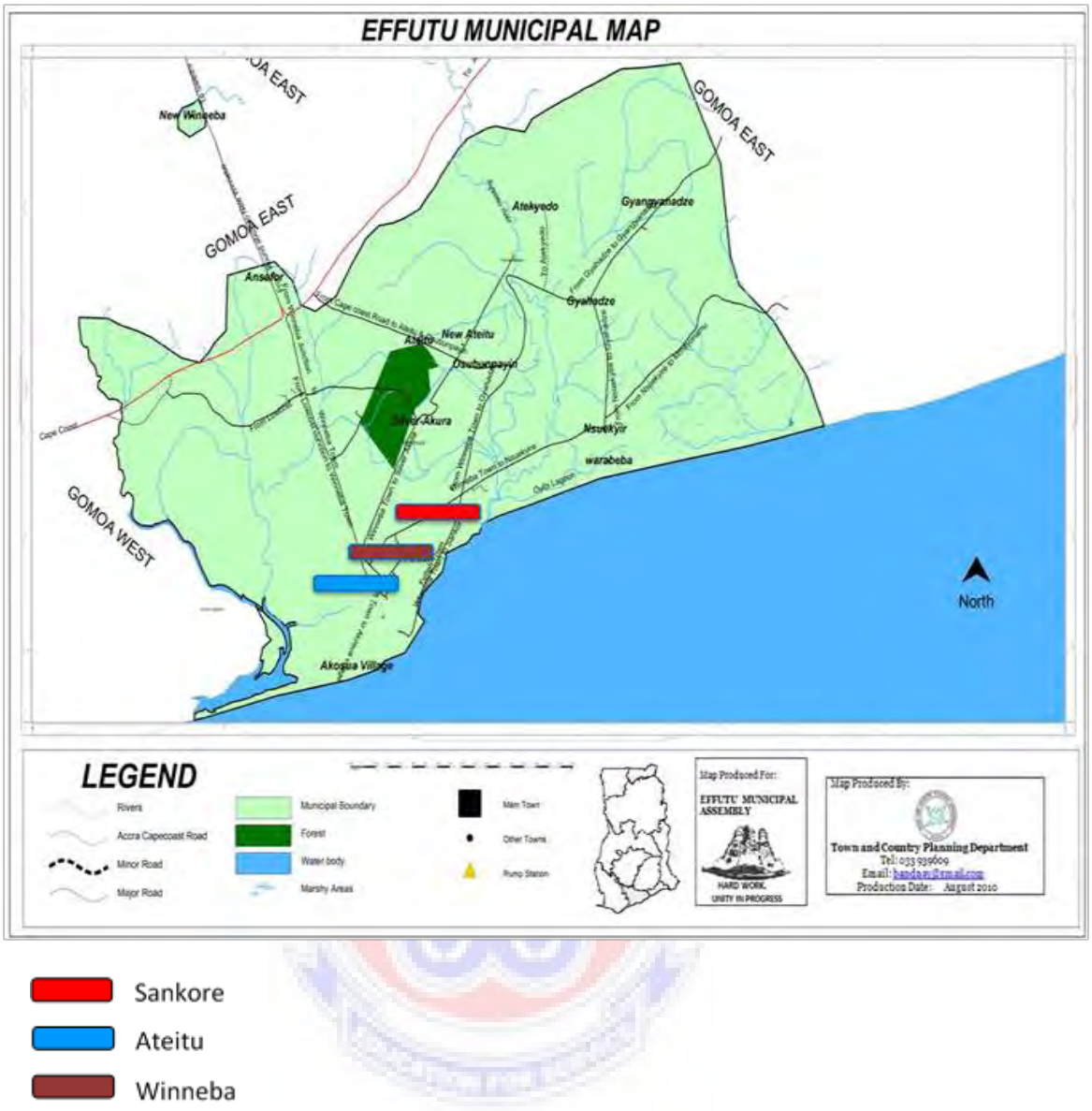

Fig.: 3.1 Profile of the study Area: Effutu Municipality

Source: Effutu Municipal Assembly

3.3 Population

Population is any set of people or events from which the sample is selected and to which the study results will be generalized (Anastas, 1999). In this study, the population was all biology students in Winneba Senior High School in Winneba. The school has six science classes in which all of them study biology as a course. This made a total population of 449.

3.4 Sample Size and Distribution

After purposively selecting three classes based on the fact that these students offer elective biology, thirty-five (35) respondents made up of 17 SHS 3, 12 SHS 2 and 6 SHS 1 students were selected using stratified and random sampling from the three classes for the study.

The justification of the sample size lies in the fact that time and resources available to the researcher were not enough to cover the entire 449 students. Also, working with a small sample made the supervision and guidance provided during the intervention easier and more effective.

Below are the classes that were selected and the percentage of respondents that were chosen:

Table 3.1: Categories of respondents

Class	Respondents	Percentage (%)
SHS 1	6	17.1
SHS 2	12	34.3
SHS 3	17	48.6
Total	**35**	**100**

3.4.1 Sampling techniques

The method of sampling was a combination of purposive and systematic random sampling. The reason for purposive sampling was that there are some classes that do not offer elective biology; such classes were not included.

Systematic random sampling technique was used to select the students for the study. The first student seated on the right row in each of the biology class was selected and

thereafter, every third student was selected until the number allotted to the class was obtained.

3.5 Research Instruments

Yin (2003) outlines four main techniques for data collection, three of them were adopted in this study. They are: Questionnaire, Interviews and Observation.

3.5.1 Questionnaire

A questionnaire was used to collect information for this study. The study made use of one structured questionnaire. The questionnaire was for all the respondents who constitute the principal target group for the study. The questionnaire consisted mainly of closed-ended questions. The purpose of the questionnaire was to find out the perception of the respondents on biological drawing, labeling and identification. Majority of the questions were pre-coded with multiple-choice responses. Few other questions were open-ended seeking respondents to provide the specific response (Appendix I).

3.5.2 Observation

In addition to the questionnaire, participants were observed to clarify and ascertain the truth or other issues the respondents raised. This method was appropriate because, a lot of issues relating to biological drawing and identification was identified while the students were engaged in practical work. An observational check list (Appendix II) was designed to help the researcher.

Worthy of note was the issue of the type of pencils that were used for the drawings, the type of paper they used, and how independent the participants were during the practical lesson. Inspections were also conducted on previous drawings of students in

their work book. This provided the researcher with first-hand information on issues related to the study and in-depth qualitative data was generated by the use of this technique.

3.5.3 In-depth interview

Semi-structured in-depth interviews were conducted with the sampled biology students. These interviews were undertaken to identify the problems biology students face in identification, biological drawing and labeling. An interview guide (Appendix III) was designed to guide the researcher. The in-depth interview was also appropriate for interviewing students with busy schedules. It generated in-depth information regarding opinions about the study. The interviews were held on 6thFebruary, 2019 to 15th February, 2019.

3.6 Actions Taken

The major research instrument, the questionnaire and a practical exercise were administered in two phases.

3.6.1. The Pre intervention stage - without computer- assisted teaching

A pre-test (Appendix V) was administered to the sampled biology students to know their level of knowledge on specimen identification, drawing and labeling after they were taught with the activity method. With permission from the Biology Head of Department, all the 35 students selected for the study were made to identify, draw and label a specimen at the biology laboratory in 20 minutes. After this, the sheets were collected for observation and analysis. The results obtained during this stage were recorded and analyzed. The pre intervention stage was conducted within two weeks.

3.6.2 Intervention stage: Computer Assistance

The researcher booked an appointment with the school's ICT department to use the computer laboratory. The computer application (YouTube) and a projector was used to teach the sampled students how to identify, draw and label specimen in biology. YouTube videos showing how to make biological drawings, how to label, and how to identify specimen were projected and played for the respondents to watch and listen. Respondents were observed by the researcher as they watch the videos. Observations were recorded and analyzed within six weeks.

3.6.3 Post intervention stage: Results

A post-test (Appendix V) was conducted after the students have gone through computer- assistance in teaching specimen identification, drawing and labeling. The selected students were made to identify, draw and label a specimen at the biology laboratory in 20 minutes. The researcher observed the students as they work. An observational check list (Appendix II) guided the researcher during the observation. All observations were recorded and the sheets for the post-test were collected for observation and analysis.

This was to identify the impact of using computer- assisted teaching of identification, biological drawings and labeling on students. The pre- intervention stage was conducted within two weeks.

3.7 Validation of Instruments

Questionnaire validation is a process in which the creators review the questionnaire to determine whether the questionnaire measures what it was designed to measure (Creswell 2007). Content validation of the questionnaire was done using the pre-test method. This refers to observing all the specific items on the questionnaire to

determine whether the questionnaire addresses the overall topic. After this, the main study was preceded by a pilot test using five biology students and one biology teacher.

The main aim of the pilot study was to improve the items on the questionnaire. Those who took part in the test were biology teachers and selected biology students in the SHS 3 class of Winneba SHS. They were given the opportunity to comment on the quality of the questionnaire. This allowed the researchers to ensure that every item corresponds to a desired measurement and that everything that should be measured was actually measured.

My supervisor reviewed the final questionnaire for relevance and clarity. Their suggestions helped a lot in framing the final questionnaire for the study.

3.8 Data for the Study

Both primary and secondary data were employed for the research. Primary data was collected between 1st February and 21th February, 2019. Interviews, observations and administration of questionnaire were used to gather the primary data.

Secondary data were gathered from the West African certificate examination results and reports of researches conducted on the effects of using CAI in teaching. These were obtained from libraries of the University of Education, Winneba and the Winneba Senior High School library.

3.9 Data Analysis

The data was analyzed quantitatively and qualitatively. Data obtained from questionnaire, pre-test and post-test, observation and in-depth interviews were coded and analyzed using Excel. The final output has been presented basically in the form of

texts and direct quotes from the respondents. The texts and transcribed messages are buttress with relevant pictures, tables and figures.

The analysis was done in two parts. The first was when the students drew and label without computer- assistance and the second was after the students received computer assisted lesson. A paired t-test was conducted on the pre and post-test to find out the difference in the mean score. (Appendix VI).

3.10 Research Ethics

The researcher abided by the principle of respect for all respondents, therefore a commitment was made to the participants that their privacy would be protected. Creswell (2007), advised that whenever a research is conducted on people, the security of respondents must be a top priority. The research is not more important than the privacy and rights of the respondents. This means that if a choice must be made between doing harm to a participant and doing harm to the research, it is the research that is sacrificed. In this research project, the researcher abided by the ethics of research by seeking the consent of participants to participate. Respondents were therefore given codes from WI-W35 to conceal their identity.

3.11. Limitations of the Research Methods

There were several limitations that characterized the use of action research methods in this study that warrant attention in interpreting the results of this study. First, the size of the laboratory. The school has only one biology laboratory that can take a maximum of 35 students at a time. The researcher could have used a larger sample if there was a larger laboratory. The second limitation is the number of computers present at the computer laboratory at the time of the study. There were only thirty-five computers that were functioning at the time of the research and this limited the

researcher to choose the small sample size of students participating in this study. A third limitation was the access to the computer laboratory and internet access. Since, the school has only one computer lab with only thirty-five functioning computers, getting access to the place was a problem. Even when the researcher had access to the lab, getting access to the internet was also a problem.

The fourth limitation was time constraint, since the sample were from different forms, at times the respondents have to wait a few minutes after school to undergo the intervention stage. The final limitation was the financial problems the researcher faced during the study.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Overview

This chapter discusses the results obtained from pre-test and post-test, questionnaires, observation and interviews on causes of poor drawing, specimen identification and labeling. The first part of this chapter deals with the analysis of results and the second part discussed the results.

4.1 Class of Respondents

The respondents were at different levels in the Senior High School. Six (6) SHS 1 students, twelve (12) SHS 2 students and seventeen (17) SHS 3 participated in the survey. More students were selected from SHS 3 because they had experience more years in the teaching and learning of biology and could readily tell the difference in the teaching methods used to teach the subject. Also, they were preparing to write their final examination, hence they needed more assistance. SHS 2 also had the next higher number because they also had few months to prepare for their final exams. Only few were selected from SHS 1 because they have more time ahead of them. This is shown in the Table 4.1:

Table 4.1: Academic level of Respondents

Class	Frequency (n)	Percentage (%)
SHS 1	6	17.1
SHS 2	12	34.3
SHS 3	17	48.6
Total	**35**	**100**

4.2 Analysis from Research questions

Methods of Teaching

Research question 1*: What are the methods employed by teachers to teach identification of specimen, drawing and labeling in biology?*

4.2.1 Methods used to teach specimen identification

Students were asked to specify the method that was used to teach them specimen identification in class. Out of the 35 students, 12.5% said lecture method was used to teach them the topic, 62.5% said activity method was used by their teacher to teach the topic, 6.25% said discussion method was used to teach the topic. Three (3) of the students representing 18.75% said they were not aware of the method the teacher employed in teaching the topic. None of them mentioned computer- assisted method as to what was used to teach the topics. (Figure 4.1).

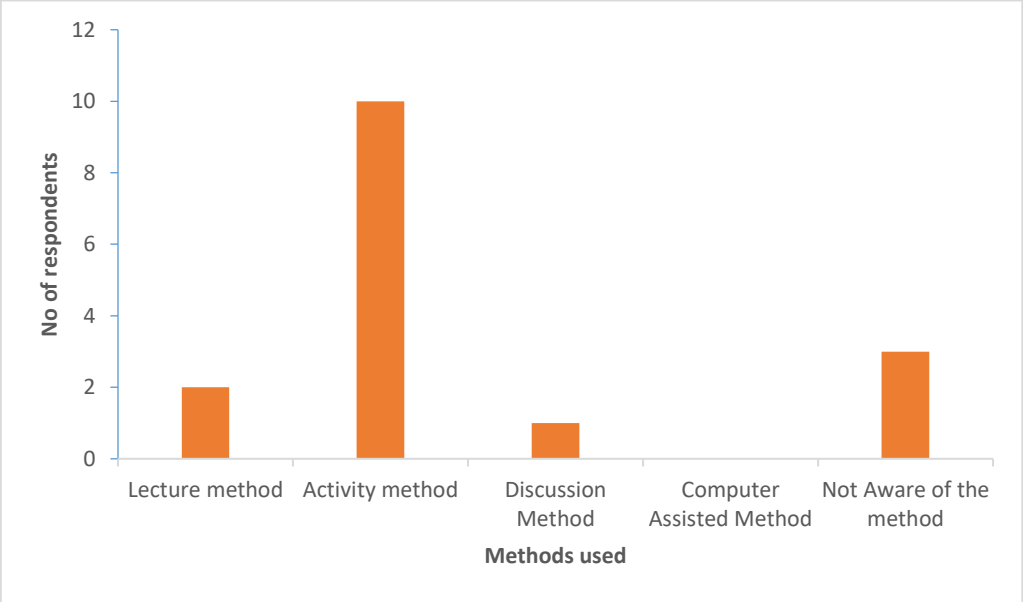

Figure 4.1: Methods used by Teacher to Teach Specimen Identification

4.1.3 Methods used to teach Biological drawing

The students were asked to specify the method used in teaching them biological drawing in class. Out of the 35 students, 11.8% said lecture method was used to teach them the topic, 70.6% said activity method was used by their teacher to teach the topic, 5.9 % said discussion method was used to teach the topic. Two (2) of the students representing 11.8% said they were not aware of the method the teacher employed in teaching the topic. None of them mentioned computer -assisted method as the method used to teach them. This is shown in Figure 4.2.

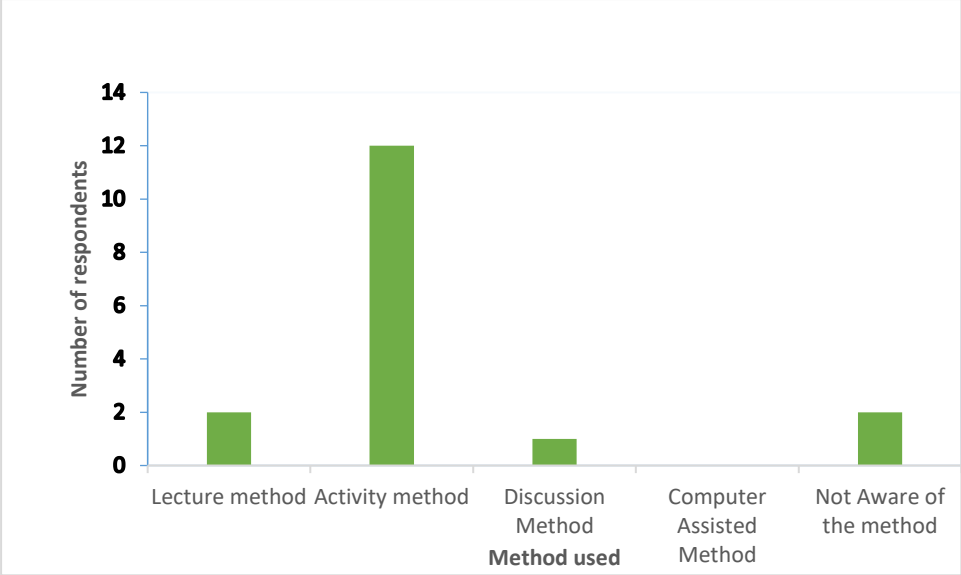

Figure 4.2: Methods used by Teacher to Teach Biological Drawing

4.1.4 Methods used to teach Labeling in Biological drawing

In Figure 4.3, the students were asked to specify the method that was uses to teach them biological drawing in class. Out of the 35 students who said they have been taught the topic, 19.0% said lecture method was used to teach them the topic, 71.4% said activity method was used by their teacher to teach the topic, 4.8 % said discussion method was used to teach the topic. One (1) of the students representing 4.8% said they were not aware of the method the teacher employed in teaching the topic. None of them mentioned computer assisted method as the method used to teach the topic.

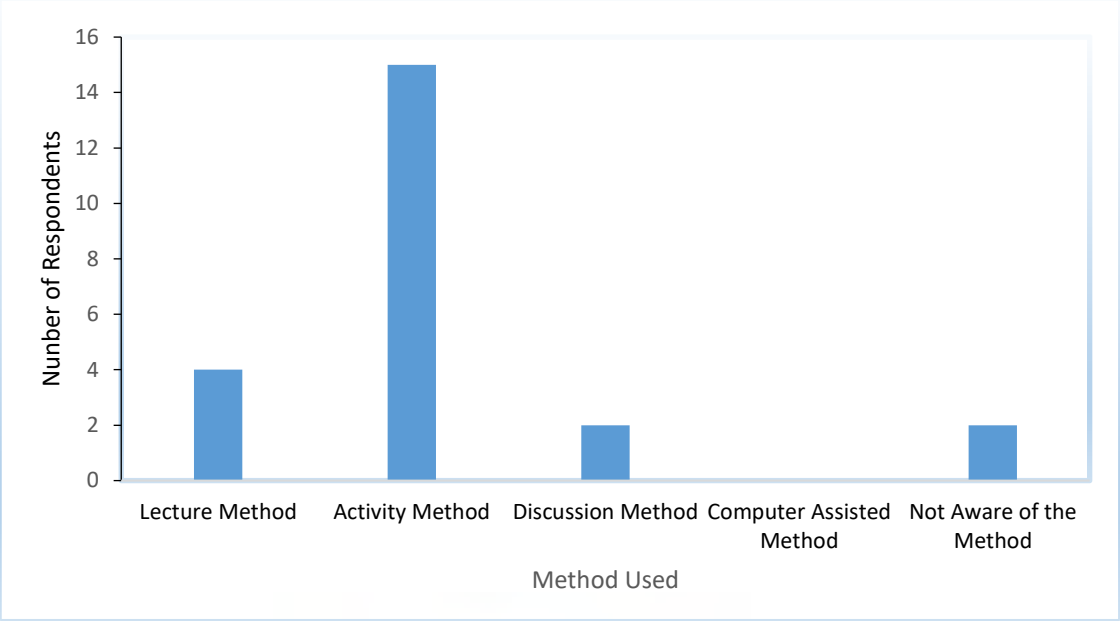

Figure 4.3: Methods used by teachers in teaching labeling in biology

4.3 Rules in the identification of specimen, drawing and labeling in biology

Research question 2*: To what extent do students know the rules to be observed in the identification of specimen, drawing and labeling in biology?*

Table 4.2: Rules in Specimen Identification, Drawing and Labeling in Biology A

Items	Agree	(%)	Disagree	(%)	Total
Any pencil can be used to draw in biology	21	60	14	40	100
Only plain white paper can be used in drawings.	17	48.6	18	51.4	100
Erasers are allowed in biological drawings	31	88.6	4	11.4	100
Pens can be used to draw on clean papers	5	14.3	30	85.7	100
Diagrams should always be centered on the page	16	45.7	19	54.3	100

Item 1 of Table 4.2 which reads – Any pencil can be used to draw in biology shows that out of the 35 respondents, 21 agreed and 14 disagreed. The 21 agreeing out of the

35 respondents implies that a greater percentage of the students agreed that any pencil can be used in biological drawing. According to Zweifel (2007), not every pencil can be used in biological drawing. He further stated that it's only 2H or HB pencils that can be used in biological drawing.

During the interview session, the researcher gave codes from W1-W35 to the sampled students for easy identification.

In an interview with respondent W5, she had this to say:

> *My teacher told me that any soft pencil can be used in biological drawings. He never told me or any of my mates to buy a specific pencil for drawing. If he had told me like I will buy one and use because pencils are not very expensive.*

The assertion by W5 shows that some teachers could be blamed for students' poor drawings in biology. The 2018 WAEC chief examiner report stated clearly that many biology candidates showed lack of knowledge regarding drawing in the examination. This also confirms what Zweifel (2007) found that, if teachers do not explain and enforce ground rule in biological drawings the students will not be perturbed to do the right thing.

Another student (W7) however, had a different view from respondent W5. According to her:

> *My teacher told us that it's only 2H pencils that can be used in biological drawing. He always insisted on the use of that pencil in class, he sometimes punishes any students who fail to use the appropriate pencil in drawing.*

The above interview with W5 and W7 shows that even though some teachers are not teaching the right things, others too are really doing well. The study results indicated that majority of the respondents (about 60%) had the idea that biological drawings are drawn in pencil. However, 40% of the respondents did not agree to this, meaning that

they think that any pencil can be used in making biological drawing. Using pencils like BB, 3B and 4B or ball pen in making drawings of specimens lowers performance in examinations testing on drawing (Jepson, as cited in Allan et al., 1994). This could indicate lack of guidance from teachers and poor provision of learning resources like pencils by parents and guardians. It also indicates lack of knowledge about the correct pencils required to make biological drawings. Use of other pencils and ball pens makes correction of mistakes in the drawings difficult and often leads to untidy drawings.

Item 2 of Table 4.2, which reads- Only plain white paper can be used in drawings, 17 agreed whiles 18 disagreed. The 18 disagreeing out of the 35 students shows that a greater number of teachers are not doing the right thing. Meanwhile, Lerner (2007) said that only white, unlined paper should be used in biological drawing.

A student (W3) in an interview said that, even though her teacher told them to buy drawing book for drawing, she never insisted on it. She always makes her drawings on lined papers and she is not punished.

Another student (W9) interviewed from a different class however said something different:

He said, our teacher told us to bring sketchbooks to school for biological drawings only. That is what we have been using for all our drawings in biology.

Responses from the students interviewed clearly depicts that so many teachers are not teaching and enforcing the rules in making biological drawings. Some teachers are therefore to be blamed for student's poor performance in biology in both internal and external examinations.

Item 3 of Table 4.2, which reads: Erasers are allowed in biological drawings shows that out of the 35 respondents, 31 agree that erasers are allowed in biological drawing whiles only 4 disagreed. This indicates that majority of the students know the rules, so teacher are doing the right work. This assertion is in line with Zweifel (2007) which stated that clean eraser can be used for mistakes.

In an interview with a student (W15) she said: we are allowed to use eraser whenever we make mistakes. But our teacher always advices us to buy good ones that will not make our work dirty.

Another student interviewed from a different class (W1), also said that her teacher allow them to use erasers when drawing, just that she always advise them to buy good ones that will not make their work dirty.

The above responses are in line with what the West Africa examination council (WAEC) requirement that, students can use clean erasers for their mistakes. Teachers are therefore teaching what is right.

Item 4 of Table 4.2, which reads: Pens can be used to draw on clean papers. Five students only agreed that pens can be used in making biological drawings. A greater number that is 30 students disagreed that pens can be used in making biological drawings. The 30 students disagreeing out of a total number of 35 clearly indicates that a greater number of teachers are really teaching what is right. This is exactly the same as what Lerner (2007) said, that only pencils and to be precise HB and 2H can be used in making biological drawings.

Two students' W11 and W21 who were interviewed all said that their teachers always punish them when they use pen in drawing. One of the students W21, continued by saying that "it is very difficult to erase pen when you make a mistake, so why do you

even use it". These responses from the students are also in line with the West Africa examination council (WAEC) requirement which said, only pencils can be used in making biological drawings. This clearly indicates that many teachers at the senior high school level are enforcing the basic rules in biological drawings and this will perturb the students to do the right thing.

Item 5 of Table 4.2 which also reads: Diagrams should always be centered on the page recorded 16 agreed and 19 disagreed. Considering the percentages of those who agreed to those who disagreed, it is clear that many of the students are not aware that biological drawings are to be centered as stated by Zweifel (2007) that "keep your drawings to the left of the center of the page and save the right hand side of the page for labels".

Two students who were interviewed (W13) and (W25) all said the same thing that they are not aware that biological drawings should be centered in the left side of the page. This is what W13 said:

> *I am not aware that it is a rule that all biological drawings should be centered at the left side of the page whiles the right side is left for labels. I just draw without following this rule.*

W25 also said:

> *Even though I normally place my diagrams at the center of the page I never knew that it is a rule. I just do it unconsciously, I was not thought by my teacher.*

The above responses from the respondent W13 and W25 clearly depicts that, like the responses from the questionnaires, students are not thought that all biological drawing should be at the center of the page. This shows that some teachers at the senior high school level are not aware of some of the basic rules to be observed in making good biological drawings.

Table 4.3: Rules in Specimen Identification, Drawing and Labeling in Biology B

Items	Agree	(%)	Disagree	(%)	Total
Drawings should be large enough to easily represent all details visible under the microscope.	32	91.4	3	8.6	100
Show only as much detail as necessary to represent the relevant features of the specimen.	8	22.9	27	77.1	100
You do NOT have to draw everything.	30	85.7	5	14.3	100
Drawings should accurately represent reality.	17	48.6	18	51.4	100
If you see a complete oval in your specimen, your drawing should be a complete oval,	30	85.7	5	14.3	100

Item 1 of Table 4.3 which was responses to the question which reads: Drawings should be large enough to easily represent all details visible under the microscope. Out of the 35 students who responded to the questionnaire, 32 agreed whiles only 3 disagreed. According to Zweifel (2007), drawings must be large enough to show all parts without crowding. The greater the number of parts to be included, the larger the drawing should be. Drawings must be about half a page in size.

In an interview with W1 and W23, this is what they said:

> *W1 said, my teacher always punishes us whenever we make small drawings. She said that all our drawings should take at least a half of the page and she always insists that we use sketchbooks for our drawings because for sketchbooks the pages are very large.*
>
> *W23 also added to what W1 said that "our teacher always advices us to make our drawings large enough in other to show all parts present." She added that his teacher always will cancel small*

diagrams and will always insists that drawings are always large enough to show all the parts present and clear.

Item 2 of Table 4.3 Show only as much detail as necessary to represent the relevant features of the specimen. From the responses from the questionnaires 8 of the sampled students agreed to the question whiles 27 disagreed to the question. According to Zweifel (2007), show only as much detail as necessary to represent the relevant features of the specimen".

This clearly indicates that many senior high school teachers are not doing their work well, they are not teaching students the correct biological drawing rules.

After an interview with W15 and W21, this is what they aid:

W15 said, my teacher said I should draw all that I see. She said that I should not draw some and leave some. She said I should draw everything.
W21 also had this to say, "my teacher always advices us that when drawing we should draw as much detail as possible.

Responses from the questionnaire and from the interview indicates that the students have been taught well by their teachers.

Item 3 of Table 4.3, which was responses to the question which reads: You do NOT have to draw everything. 30 students agreed whiles only 5 students disagreed. But according to Aggarwal (2001), you should draw what you see and not what you want to see, meaning you should draw everything you see. An interview with W5 and W17 also indicates that students were not though the right rule.

W5 said, my teacher did not say anything about whether we should draw everything or not, but I think you do not have to draw everything because some diagrams and some specimen have too many parts.

W17 also said that she has no idea whether she should draw everything or not because her teacher was not specific on that. The above responses to the questionnaire and the interview shows that some students do not know some of the basic rule to observe in biological drawing. According to Aggarwal (2001), you should draw what you see and not what you want to see. Therefore if teachers do not explain and enforce ground rule in biological drawings the students will not be troubled to do the right thing.

Item 4 of Table 4.3, which were responses to the question which reads: Drawings should accurately represent reality. Student's responses from the questionnaire indicates that 17 students agreed to the question whiles 18 student sdisagreed to the question. According to Zweifel (2007), biology is the study of living things and since all living things are real, drawings made of them should accurately represent reality.
On this question 2 students were interviewed, W3 and W35. W35 said that her teacher told them in class that whenever they are making biological drawings, the drawings should always represent the real object and it should also represent reality.

W3 however said that even though his teacher taught them some rule to observe when making drawings in biology, he did not mention that rule to them. The responses are clear indication that even though some teachers are trying very hard to teach the basic rules in biological drawing, others don't even know some of the basic rules in biological drawing.

Item 5 of Table 4.3, which was responses to the question which reads: If you see a complete oval in your specimen, your drawing should be a complete oval. Out of the 35 students who responded to the question, 30 students representing 85.7% agreed whiles 5 students representing14.3% disagreed. Zweifel (2007), stated that you should

draw what you see and not what you want to see. Therefore if you see a complete oval in your specimen, your drawing should be a complete oval.

Two students W11 and W29 who were interviewed on this question said:

> *W11 said "my teacher always insists that we should always draw whatever we see and not what we think is there. Therefore as for me if I see a complete oval in my specimen I will draw a complete oval. W29 also said the same thing, he said," my teacher said that in biological drawing you should always draw what you see and not what you think, so I will draw a complete oval if I see a complete oval".*

The above responses to the questionnaire and interview clearly shows that many biology teachers at the senior high school level are enforcing the basic rules in biological drawing in their teaching.

Table 4.4: Rules in specimen identification, drawing and labeling in biology C

Items	Agree	(%)	Disagree	(%)	Total
Proportions should also be accurate.	9	25.7	26	72.3	100
You can draw from memory.	31	88.6	4	11.4	100
Look at specimen for 5 seconds, then draw for 5 seconds. Repeat until finished.	9	25.7	26	74.3	100
Never use shading.	31	88.6	4	11.4	100
Never draw when you are not looking at the specimen.	29	82.9	6	17.1	100

Item 1 of Table 4.4 are responses to the question, Proportions should also be accurate. 9 students agreed to the question whiles 26 students disagreed to the question. Majority of the students disagreeing to this question depicts that students don't know the basic rules in biology. According to the WAEC chief examiners report (2018),

"majority of the candidates could not produce good biological drawings". Allan, Reed and Weyers (1994), also stated that, proportion should be accurate when drawing. An example was given on when drawing a fruit and a seed. The proportion of the fruit and the seed should always be taken into consideration. It should always be accurate.

When an interview with W13 and W23 was over, W13 said:

> *I don't know anything about proportion in biological drawing. Whenever I am drawing I don't take the proportion into consideration, I just draw.*
>
> *W23 on the other hand said he always take the proportion of each part into consideration when he is drawing. He gave an example of the drawing of the cell and its organelles. He said that when drawing a plant cell, the proportion of the nucleus, mitochondrion, vacuole and others must be taken into consideration. It should always be accurate.*

The above answers shows that even though some biology teachers are not enforcing the basic biological rules, others too are really doing the right thing.

Item 2 of Table 4.4, are responses to the question, you can draw from memory. Out of the 35 students who responded to the question, 31 representing 88.6% agreed whiles 4 students representing 11.4% disagreed. But Aggarwal (2001), noted that "you can't use your creative brain to draw biological diagrams on your answer sheet. He continued by saying that improvisation isn't acceptable in biological drawings, especially when you are involved in drawing the diagram of a human brain or a human heart, improvisation is a big no-no.

Two students, W33 and W17 who were interviewed on this question also had this to say:

> W33 said, "My teacher always advices us that whenever we are drawing we should draw exactly what is in front of us and not what is in our mind. She always says that pictures we see in our

> textbooks may not be exactly as what is in front of us, some parts may be either absent or present".

W17 also said something similar. He said whenever I am drawing I draw what I have in front of me and not what I have in mind. What I have in mind may not be like what is in front of me. My teacher always says that there is no improvisation in biological drawing. Considering the above responses, it can be said confidently that indeed majority of the biology teachers are really doing good by teaching students the right rules needed in making good biological drawings.

Item 3 of Table 4.4, also responses to the question, Look at specimen for 5 seconds, then draw for 5 seconds. Repeat until finished. 9 out of the 35 students representing 25.7% agreed whiles 26 students representing 74.3% disagreed. Keep looking back at your specimen whilst you are drawing. Majority of the respondents disagreeing implies that greater percentage of the students are not aware that they should keep looking at the specimen as they draw. These responses could mean lack of guidance from teachers and reduced supervision of learning during practical lessons. It also indicates lack of knowledge about what to do when drawing a specimen is in front of them and when the specimen they are drawing is under a microscope. This can lead to untidy drawings and may also lower performance in examinations testing on drawing (Jepson, as cited in Allan *et al.*, 1994).

When drawing from a microscope it is useful to look down the eye piece with one eye and at the drawing paper with the other - it takes practice, but it is possible Billiet (2003).

Item 4 of Table 4.4, also responses to the question, never use shading. 31 out of the 35 students representing 88.6% agreed to the question and only 4 students

representing 11.4% disagreed. The 31 (88.6%) agreeing out of the 35 respondents implies that greater percentage of the students agreed that shading can never be used in biological drawing. According to Zweifel (2007), shading specific areas of a diagram might kook aesthetic to the eye, but this practice is not acceptable in biology. Hence the advice is to AVOID at all cost.

In an interview with respondent W35, she had this to say:

> *My teacher said we shouldn't shade, she said that shading is totally forbidden in biological drawing. She said if we wish to indicate a darker area we should use dots (stipple). She continued by saying that shading obscures some of the structures hence leading to congestion of structures in the drawing.*

About 88.6% of the students agreeing means that biology teachers are guiding students in doing the right thing.

Item 5 of Table 4.4, also responses to the question: never draw when you are not looking at the specimen. 29 students agreed to the question whiles only 6 students disagreed. As noted by Allan, Reed & Weyers (1994) that, biological drawing is an accurate representation of the specimen. To produce such a drawing, the learner should be a keen observer. This skill will enable the learner to include all the key structures of interest in the biological drawing made, in their correct position, size and length. Drawing while looking elsewhere may lead to improper drawing and should therefore be avoided. The results indicates that majority of the students draw the structures whiles looking at the way they appear on the specimens. But 6 students disagreeing means that some s tudents' lack observational skills and may not include key structures in the drawings they drew. This amounts to an incorrect representation of the specimen.

This lack of observation skills can be attributed to:

a) Lack of practice in making biological drawings. Lerner (2007) noted that, a pencil is one of the best eyes to the biologist. Drawing in Biology makes learners active participants in creation of meaningful knowledge, rather than passive repositories of information. A careful examination of specimen is secured best by careful sketching. Drawing is not only an excellent device for securing close observation, but a rapid method of making valuable notes. The results imply that teachers preferred a theoretical approach to the teaching of Biology.

b) Lack of guidance during practical lessons. Just like any other skill, the skill of observation should be learned. This requires guidance by the teachers, especially during practical sessions.

Lack of observational skills makes the data recorded and presented in form of drawings inadequate due to omission of key information. If this occurs in an examination it leads to dismal performance.

Table 4.5: Rules in specimen identification, drawing and labeling in biology D

Items	Agree	(%)	Disagree	(%)	Total
Labeling lines should always be made with a ruler	33	94.3	2	5.7	100
Labeling lines should never cross.	17	48.6	18	51.4	100
Keep labeling lines vertical or horizontal	12	34.3	23	65.7	100
Leave a good margin for labels.	17	48.6	18	51.4	100
Indicate title above drawing which accurately identifies the specimen	12	34.7	23	65.7	100

Item 1 of Table 4.5, are responses to the question, labeling lines should always be made with a ruler. Out of the 35 students who responded to the question 33 students representing 94.3% agreed whiles 2 students disagreed. The results show that majority of the respondents are aware that label lines should always be made with a ruler. According to Lerner (2007), Use a ruler for label lines and scale bars. This indicates that a greater percentage of the senior high school teachers are enforcing the basic biological drawings rules.

An interview was conducted with W3 and W29 and this is what they said:

> *W3 said before we started drawing this semester my teacher listed some materials we will need for the drawing and he added along ruler to the list. He insisted that we all have the materials he listed on the board. He said that the long ruler will be used in making labeling lines when drawing.*

W29 also said something similar to that of W3. She said:

> *My teacher always say that we shouldn't use our free hands when drawing labeling lines. Using a ruler will make your work neat but free hands will make your work dirty.*

Responses from the questionnaire and interview confirms that many students are aware of the basic rules in biological drawing, therefore teachers at the basic school level are teaching the right thing.

Item 2 of Table 4.5, are responses to the question: Labeling lines should never cross. 17 students agreed to this statement whiles 18 students disagreed. However, 48% of the respondents agreeing to this show that about half of the students are not aware that in labeling biological diagrams label lines should not cross each other. Meanwhile Zweifel (2007), stated that" Arrange label lines neatly and make sure they don't cross over each other. It is visually attractive, though not essential, if the length of the label lines is adjusted so that the actual labels are right or left justified, i.e. line up vertically above each other on either side of the drawing". These responses could indicate lack of guidance from teachers and poor supervision of learning during practical lessons. It also indicates lack of knowledge about how label lines should be drawn by most of the biology teachers. Crossing label lines when drawing often leads to untidy drawings and may also lower performance in examinations testing on drawing (Jepson, as cited in Allan et al., 1994).

Only one student W31 was interviewed and he said whenever I cross label lines my teacher will use red pen to circle where the lines crossed and deduct some marks. I have therefore learned not to cross my label lines again.

Item 3 of Table 4.5, are comebacks to the question: Keep labeling lines vertical or horizontal. The study results indicated that majority of the respondents (about 65.4%) don't have the idea that in biological drawings label lines can either are vertical or horizontal. However, 12 students representing 34.6% of the respondents are aware that in making biological drawing label lines can either be vertical or horizontal. But

Aggarwal (2001), stated that label lines, can either be horizontally or vertically drawn. The information gathered from the questionnaire clearly indicates that most teachers are not teaching students the basic rules in biological drawing.

In an interview with two students W19 and W27, W19 said that she was not thought by her teacher that label lines should strictly be drawn either vertically or horizontally. W27 added that she is not aware and she was mot thought whether label lines should be horizontally or vertically drawn.

These responses could mean lack of guidance from teachers and reduced supervision of learning during practical lessons. It also indicates lack of knowledge about how label lines should be drawn by most of the biology teachers. This can lead to untidy drawings and may also lower performance in examinations testing on drawing (Jepson, as cited in Allan *et al.,* 1994).

Item 4 of Table 4.5 are answers to the question: Leave a good margin for labels. Considering the results, only 17 students representing 48.6% of the respondents agreed whiles 18 students representing 51.4% disagreed. The 51.4% disagreeing means that most of the students are not aware of this basic rule. As noted by Allan *et al*. (1994), a good margin should be left for labels. When labeling biological drawings, follow the guidance below:

- Use a sharp pencil.
- Label all relevant structures, including all tissues in the case of microscopy.
- Use a ruler for label lines and scale bars.
- Label lines should start exactly at the structure being labelled; don't use arrowheads.

- Arrange label lines neatly and make sure they don't cross over each other. It is visually attractive, though not essential, if the length of the label lines is adjusted so that the actual labels are right or left justified, i.e. line up vertically above each other on either side of the drawing.
- Labels should be written horizontally, as in a textbook, not written at the same angle as the label line.
- As previously mentioned, a title, stating what the specimen is, should be added at the top or bottom of the drawing.
- Add a scale bar immediately below the drawing if necessary.

In order to achieve all these when labeling a good margin must be left for labeling. W9 and W27 who were interviewed both said they don't consider margins when they are drawing. Improper labeling can give wrong implications about a particular drawing and may also make your work dirty. If this occurs in an examination it leads to dismal performance.

Item 5 of Table 4.5 are reactions to the question: Indicate title above drawing which accurately identifies the specimen. From the results 12 students agreed whiles 23 students disagreed. The 65.7% disagreeing means that most of the students are still struggling in learning the basic rules in biological drawing and labeling. As noted by Allan *et al*. (1994). That:

- ❖ All drawings are titled. The printed and underlined title appears immediately above the drawing, against the left-hand margin. The magnification of the object drawn follows the title and is in parentheses. Example: Blood Cell (300X).
- ❖ Name and date are printed in the top right hand corner.

Table 4.6: Rules in specimen identification, drawing and labeling in biology E

Items	Agree	(%)	Disagree	(%)	Total
1. Magnification should be below specimen (e.g., 100x)	5	14.3	30	85.7	100
2. Indicate names of known or identifiable structures in margins	6	17.1	29	82.9	100
3. Part of an organism can be used for identification	27	77.1	8	22.9	100
4. Identification provides a stable and universal vocabulary of an organism	5	14.3	30	85.7	100
5. Each specimen should be tagged with a correct identification	33	94.3	2	5.7	100

Item 1 of Table 4.6 are answers to the question: Magnification should be below specimen (e.g., 100x). Responses from item 1 of Table 4.6 are evident that more than 85% of the respondents were not aware that magnification should be written below the specimen. This indicates that either they were not taught the basic rules in making biological drawings or learners did not take their lessons serious. This amounts to an incorrect representation of the specimen. According to Lerner (2007), it is useful to give an indication of the scale/magnification of a drawing, particularly for large specimens drawn without the aid of a microscope. The actual size of a plant or leaf, for example, may be impossible to judge simply from a drawing. For drawings made using microscopes, if the actual scale or magnification is not given, it may be useful simply to indicate whether a low or high power lens was used, preferably the actual magnification achieved by the combined eyepiece and objective lens, usually just

below the title. He further gave the steps on how the magnification of a specimen can be calculated below:

Calculating scale or magnification of a drawing

Scale or magnification, is simply how much bigger or smaller the drawing is compared with the actual specimen. Calculate as follows:

1. Measure between two appropriate points of the drawing (e.g. total length or width).
2. Measure between the same two points of the specimen.
3. Divide measurement 1 by measurement 2.

Results obtained from interviewing 2 students W19 and W25 are as follows:

W 19 said that:

> *My teacher taught me that magnification and how to calculate it, but I have forgotten how it should be calculated and how it should be written.*

W25 said that even though she was taught how to calculate the magnification, she is not aware whether it should be written below the drawing or besides it.

Responses from the questionnaire and the interview clearly depicts that majority of the student do not have the knowledge about some of the basic rules in making simple biological drawings. Over 85% of the respondents disagreeing indicates:

a. Lack of teaching how magnification is calculated
b. Lack of practice in drawing specimens and calculating their magnification.

This may amounts to an incorrect representation of the specimen and if this occurs in an examination it may cause poor performance.

Item 2 of Table 4.6 are responses to the question: Indicate names of known or identifiable structures in margins, with lines connecting the structures to their labels. Out of the 35 respondents, only 6 students agreed to the question whiles 29 of the students disagreed to the question. Allan, Reed & Weyers (1994), noted that Label lines should start exactly at the structure being labelled; don't use arrowheads. The 29 disagreeing to this question with only 6 agreeing means that majority of the students don't know what they are doing. They don't know the basic rules in biological drawing. This indicates lack of guidance by the Biology teachers or negligence on the side of the students.

Two students W7 and W33 were interviewed had no idea at all on whether they should indicate names of known or identifiable structures in margins or whether label lines should connect the structures to their labels.

The inability of the students to respond positively to this question may be an indicator of:-

a. Lack of supervision and monitoring of students' practical work by biology teachers
b. Negative influence of wrongly drawn diagrams in charts and other sources
c. Carelessness and low aptitude on the part of the learners. If this occurs in an examination it leads to miserable performance.

Item 3 of Table 4.6 are replies to the question: Part of an organism can be used for identification. 27 out of the 35 respondents agreed to the question whiles 8 students representing 22.9% disagreed to the question. The 77.1% agreeing to the question indicates that majority of the students do not know the basic rules of identification. The chief examiners report 2018, clearly states that majority of the candidates

wrongly identify specimen. Also according to Bowles (2004), some plants do not seem to be identifiable even if they are carefully keyed out and all the essential parts are present. These plants should be sent to an expert for determination. If a likely candidate is not known locally, the specimen will have to be sent away. Other specimens are unidentifiable because they are incomplete. Usually the best method is to compare the unknown with all the known plants of the same survey and see if the characters match. A local expert may recognize the specimen, but usually botanists and herbarium staff are unwilling to tackle incomplete specimens. In the last resort the species may have to remain unknown and appear as "Carex sp." in reports. She continued by saying that, A flower and a leaf would not be enough if the key called for stem and root characters.

One student W31 who was interviewed on this said

> *I am not aware, my teacher didn't teach anything on how to identify specimen, but I think that a part of an organism can be used to identify it.*

These responses shows that many senior high school teachers are not teaching their students how to identify specimen. They only teach drawing and labeling and leave out the identification aspect.

Item 4 of Table 4.6 are replies to the question: Identification provides a stable and universal vocabulary of an organism. 5 student agreed whiles 30 students disagreed to this question. Responses from the questionnaire clearly depicts that majority of the students do not have the knowledge about some of the basic rules in identifying biological specimen. 30 of the respondents disagreeing indicates that teachers at the senior high school level either do not teach the students how to identify specimen at all or students did not understand whatever they were taught. Meanwhile the

Biological control specialists recognize the importance of taxonomy as a starting point for the introduction, conservation and augmentation of natural enemies, as extensively discussed by several authors (Clausen, 1942; DeBach, 1974; Eickwort, 1983; Schlinger and Doutt, 1964; Smiley and Knutson, 1983).

Two students W35 and W7 who were interviewed both said they have not been taught how to identify specimen. The above responses shows that many biology teachers at the senior high school level are not teaching students how to identify specimen and if teachers refuse to teach or enforce the basic rules in biological specimen identification it will not perturb the students to do the right thing and this may cause poor performance in examination.

Item 5 of Table 4.6 are replies to the question: Each specimen should be tagged with a correct identification. 33 students representing 94.7% agreed to the question whiles only 3 students representing 5.3% disagreed. The 94.7% agreeing indicates that teachers at the senior high schools are teaching students how to identify specimen. According to Bowles (2004), don't forget to make sure that each specimen is properly labeled! A specimen without a label is worthless. He continued by saying that:

Most herbaria have printed labels about 8 x 10 cm which are filled in and glued to each herbarium sheet. Such labels provides room for all the essential information noted by the collector at the time of gathering, plus a catalogue number for the plant in the herbarium register. Most herbaria now keep specimen records in a database and have programs which create labels automatically. Before collecting and donating specimens to a herbarium, you should find out the field names, sizes and codes for the database they use so that you can provide information in a consistent format.

Two students W27 and W17were interviewed on this question and this is what they said:

W27 said:

> *"I have not been taught specimen identification but I believe that every specimen should have a tag on it for easy identification."*

W17 also said:

> *My teacher taught me that every specimen should have a tag with field names, sizes and codes written on them for easy identification.*

Responses from the questionnaire and W17 who was interviewed are in agreement with what Bowles (2004) said. These are indications that even though some teachers at the Senior High School level are not teaching the right things and others too are really doing well.

Table 4.7: Rules in Specimen Identification, Drawing and labeling in Biology F

Items	Agree	(%)	Disagree	(%)	Total
Identification should be both machine and human readable	9	25.7	26	74.3	100
Identification must be unique within a collection	29	82.9	6	17.1	100
Identification may contain additional information	2	5.7	33	94.3	100
The dichotomous key is a common tool used by biologist for identification	27	77.1	8	22.9	100
Identification methods may be manual or computerized	17	48.6	18	51.4	100

Item 1of Table 4.7 are replies to the question: Identification should be both machine and human readable. Out of the 35 students who responded to the questionnaire 9

students representing 25.7% agreed whiles 26 students representing 74.3% disagreed. Majority of the students disagreeing means that the students don't know the basic rules in specimen identification. According to Lawrence and Hawthorne (2006), identification should be both machine and human readable.

W15 who was interviewed on this said that he has no idea on that question. This clearly signifies that many students are not aware of the basic rules in identifying simple biological specimen. This may mean that either the teachers themselves lack knowledge on specimen identification or students did not take their lesson seriously.

Item 2 of Table 4.7 are replies to the question: Identification must be unique within a collection. Majority of the students (82.9%) agreed whiles (17.1%) of the students disagreed. Lawrence and Hawthorne (2006), stated that, the descriptive element of a field guide should allow verification of the identity of species independently of the more concise or cursory information used for access. The majority of the students agreeing is in line with Lawrence and Hawthorne (2006). This is an indication that some of the teachers at the senior high school level are aware of the basic rules in specimen identification and are teaching the students.

W7 was interviewed on this question and he said that he was taught that when identifying specimen, labels for each specimen should be unique and different from other specimen.

Item 3 of Table 4.7 are responses to the question: Identification may contain additional information. 2 students representing (5.7%) out of the 35 respondents agreed to this question whiles 33 students representing (94.3%) disagreed to the question.

Lawrence and Hawthorne (2006), mentioned that names in Floras and monographs always include the authors. Moraes (1986) stated that, Sound information on field ecology which often cannot be expressed in the labels attached to each specimen, is of major importance to a taxonomist. The above information indicates that other information rather than just the local and scientific names are very important on labels.

A student W31 who was interviewed also responded negatively that, she has not been taught that additional information can be added to a label for understanding.

Majority of the students disagreeing to this indicates that students are not aware of some of the basic rules in the identification of specimen. This implies that majority of the teachers at the senior high schools are not teaching what is right.

Item 4 of Table 4.7 are responses to the question: The dichotomous key is a common tool used by biologist for identification. Responses from the questionnaire shows that majority of the students (77.1%) agreed whiles only (22.9%) disagreed to the question. The majority of the students agreeing signifies the many of the students know the basic identification rules and this is a good sign that teachers at the senior high school level are teaching students.

Lawrence and Hawthorne (2006), noted that:" Do not underestimate the value of a basic indented dichotomous key and crisp black text on white paper as a good access method. While they are not the most fashionable, such keys represent the clearest and an efficient way of displaying textual information for a decision tree. Until computer identification systems are as cheap, robust and future proof as field guide books,

traditional dichotomous keys should be the first default type of key you try out with your users."

Two students W13 and W19 who were interviewed on this question both said that they have no idea on what dichotomous keys are. This may be an indication that teachers do not consider the practical approach in the teaching of Biology and that learners are not exposed to identification of specimens. This has a negative impact on performance. A candidate cannot be awarded marks for wrongly identified specimen by an examiner.

Item 5 of Table 4.7 are responses to the question: Identification methods may be manual or computerized. Out of the 35 respondents 17 representing (48.6%) agreed to the question whiles 18 respondents representing (51.4%) disagreed to the question. From the results majority of the students disagreed. According to Waldchen and Mader (2001) Identification methods may be manual or computerized and may involve using identification keys. Waldchen and Mader (2001), also noted that: Traditional plant species identification is almost impossible for the general public and challenging even for professionals that deal with identification problems daily.

By using a computer-aided plant identification system also non-professionals can take part in this process. An interview was conducted on two students W3 and W21.

W 3 said:

> *I have not been taught specimen identification, but in my own view I think that now that we are in a global world specimen identification can be computerized to make it easy".*

W21 also said that her teacher mentioned it sometime ago when she was teaching but did not go into detail. But she said that specimen can be identified manually but it is

difficult, but now that computers are available specimen can be identified using computerized systems.

These responses may be an indication that teachers do not teach students how to identify specimen at all or it may be that students did not understand the lesson or did not take their lessons seriously. This may have negative impact on students' performance during examinations. A candidate cannot be awarded marks for wrongly identified specimen by an examiner.

4.4 Computer -assisted learning

Research question 3: What are the effects of computer- assisted instructions on student's ability to identify, draw and labeling specimen?

Analysis of students exercise on specimen identification, drawing and labeling before using computer assistance learning

4.4.1 Shading Drawings of Specimen

Biological drawings should not be shaded. But if there is a need to differentiate among different regions, hatching or stippling should be used (Allan et al., 1994). The shading conceals some of the structures hence leading to congestion of structure in the drawing. Majority of the respondents lacked the skill of shading biological drawings. This indicates lack of guidance by the Biology teachers or negligence on the side of the students. Figure 4.4 is a scanned drawing of one of the respondents. It makes the drawing untidy.

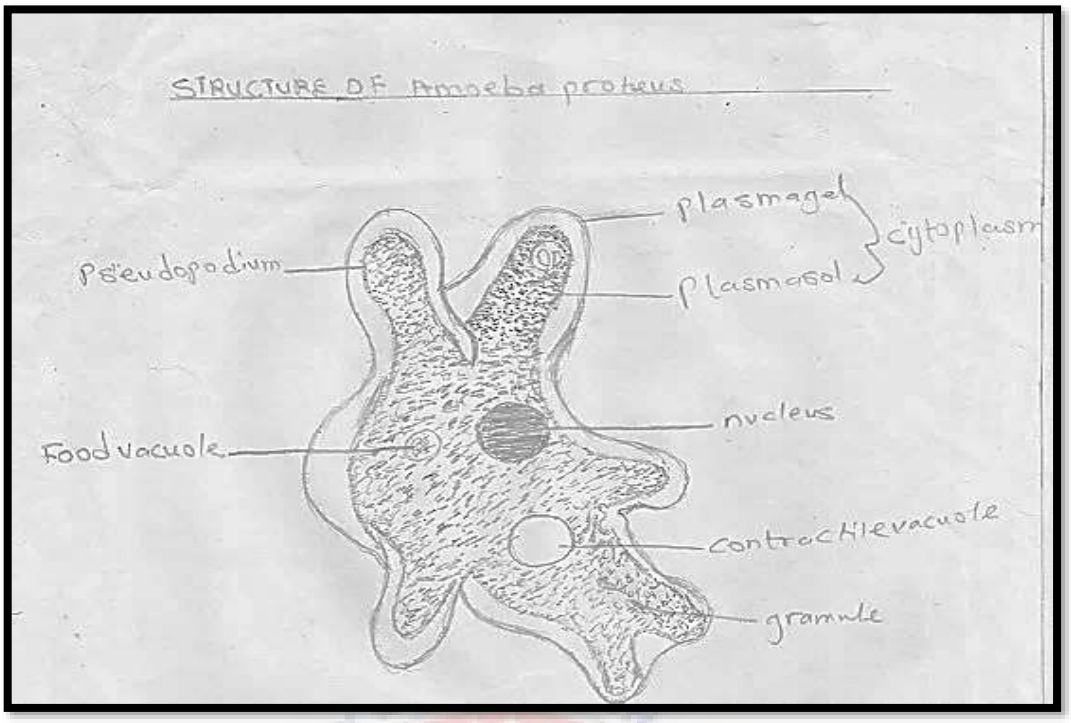

Figure 4.4: A Student's (W10) drawing of Amoeba proteus without CAI

4.4.2 Drawing Continuous Outline of Specimen

Biological drawings must be drawn with a thin, clear, visible and continuous outline. The respondents were asked to draw *Amoeba proteus* and label it as a pre-test. The results showed that the respondents were unable to make drawings with continuous outline. The drawings had scratchy outlines with junctions between structures improperly drawn. The woolly and scratchy outlines make the drawings incorrect, with incorrect record and presentation of information about the specimen apart from making the drawing untidy. The inability of the students to draw continuous outlines may be an indicator of:-

a) Lack of supervision and monitoring of students' practical work by biology teachers.

b) Negative influence of wrongly drawn diagrams in charts and other sources

c) Carelessness and low aptitude on the part of the learners.

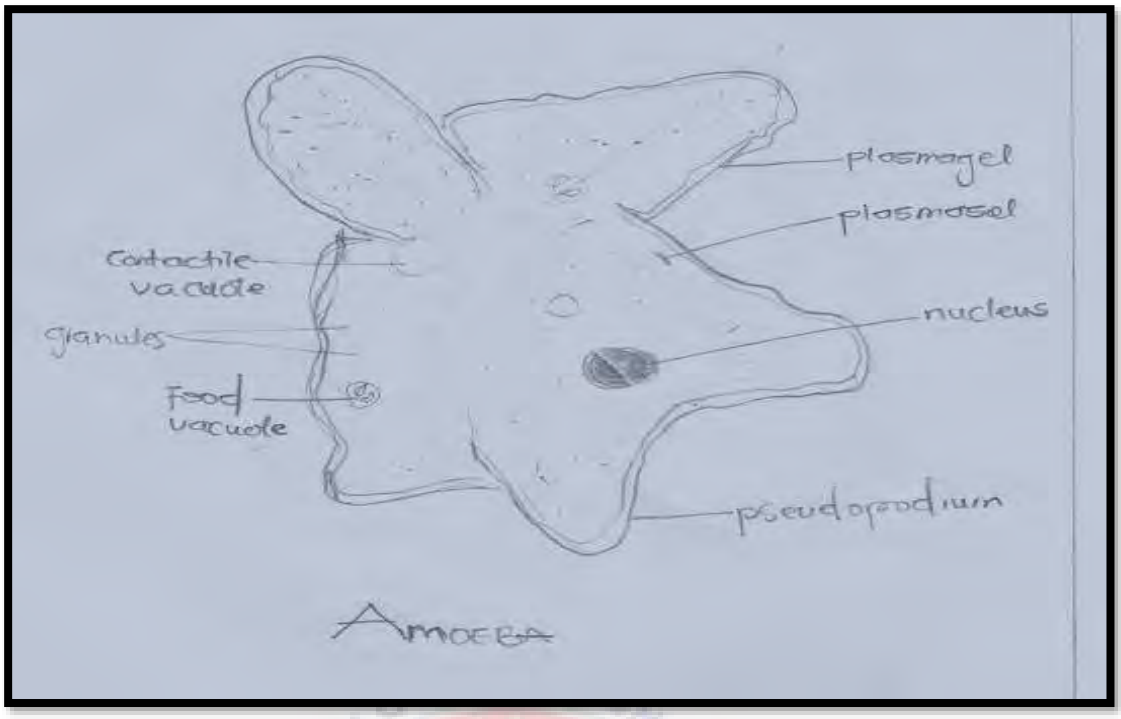

Figure 4.5: A Student's (W11) drawing of Amoeba proteus without CAI

4.4.3 Accuracy in Observation

As noted by Allan et al. (1994), a biological drawing is an accurate representation of the specimen. To produce such a drawing, the learner should be a keen observer. This skill will enable the learner to include all the key structures of interest in the biological drawing made, in their correct position, size and length.

To test this skill, the researcher tested the students by asking for drawings of *Amoeba proteus*. It emerged that most of the learners were not accurate in their observation of specimens. The respondents were not keen to note that there is difference between the contractile vacuole and the food vacuole. In this drawing, also the respondent could not show the endoplasm and the ectoplasm, which forms the cytoplasm.

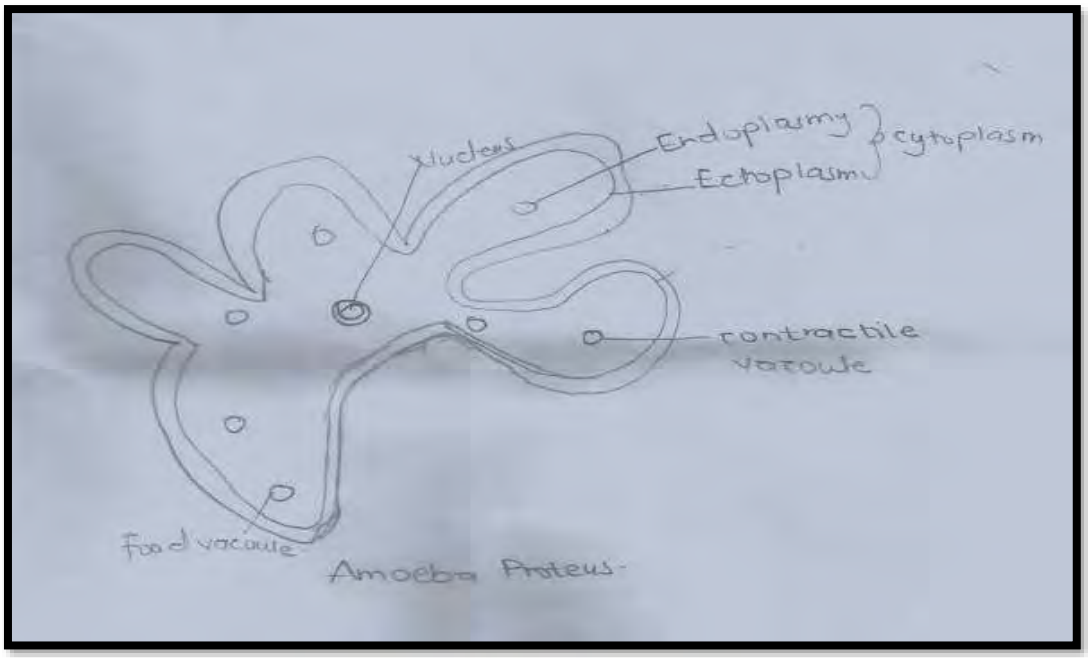

Figure 4.6: A Student (W12)'s drawing of Amoeba proteus without CAI

4.4.4 Use of Pencil in Drawing

It is highly recommended that all biological drawings be drawn in pencil to allow corrections to be made (Kilgour, 1989). The main outlines should be drawn faintly with HB pencil. When satisfied, a sharp HB or 2H pencil should be used to go over the lines firmly. The study results indicated that majority of the respondents (over 72%) had the idea that biological drawings are drawn in pencil. However, this respondent used ball pen. Use of ball pen in making drawings of specimens lowers performance in examinations testing on drawing (Jepson, as cited in Allan et al., 1994). This could indicate lack of guidance from teachers and poor provision of learning resources like pencils by parents and guardians. It also indicates lack of knowledge about the correct pencils required to make biological drawings. Use of ball pens makes correction of mistakes in the drawings difficult and often leads to untidy drawings.

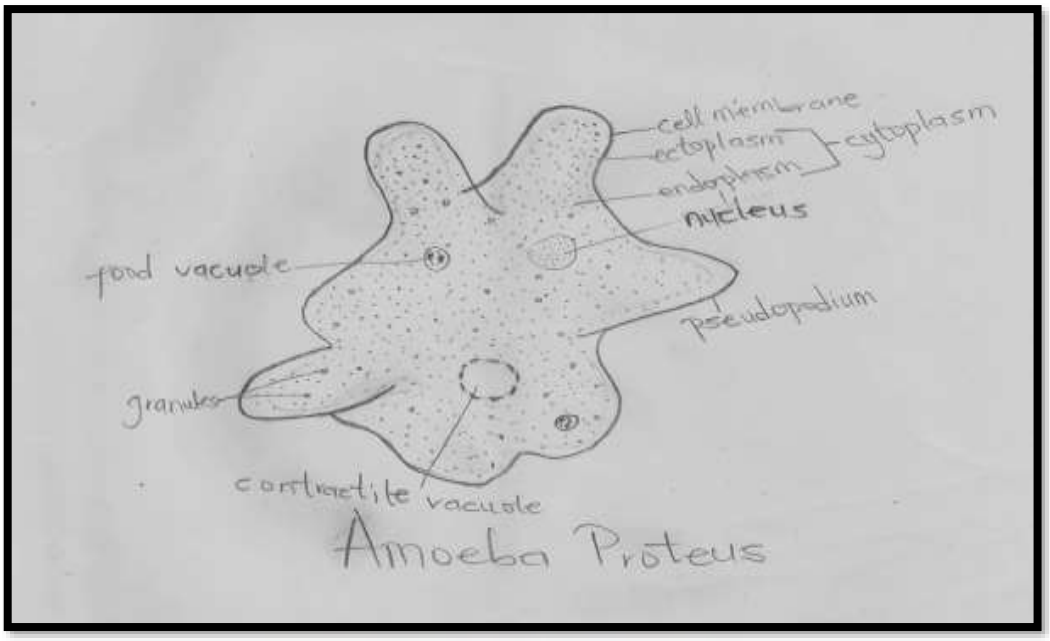

Figure 4.7: A Student (W13)'s drawing of Amoeba proteus without CAI

4.4.5 Labels and label lines

Zweifel (2007), stated that" Arrange label lines neatly and make sure they don't cross over each other. It is visually attractive, though not essential, if the length of the label lines is adjusted so that the actual labels are right or left justified. Label lines should not cross labels.

To test this skill, the author tested the students by asking for drawings of *Amoeba proteus* and it appeared that most of the learners were not able to draw labels and label lines correctly. In this drawing, the label lines crosses the labels and this is biologically wrong.

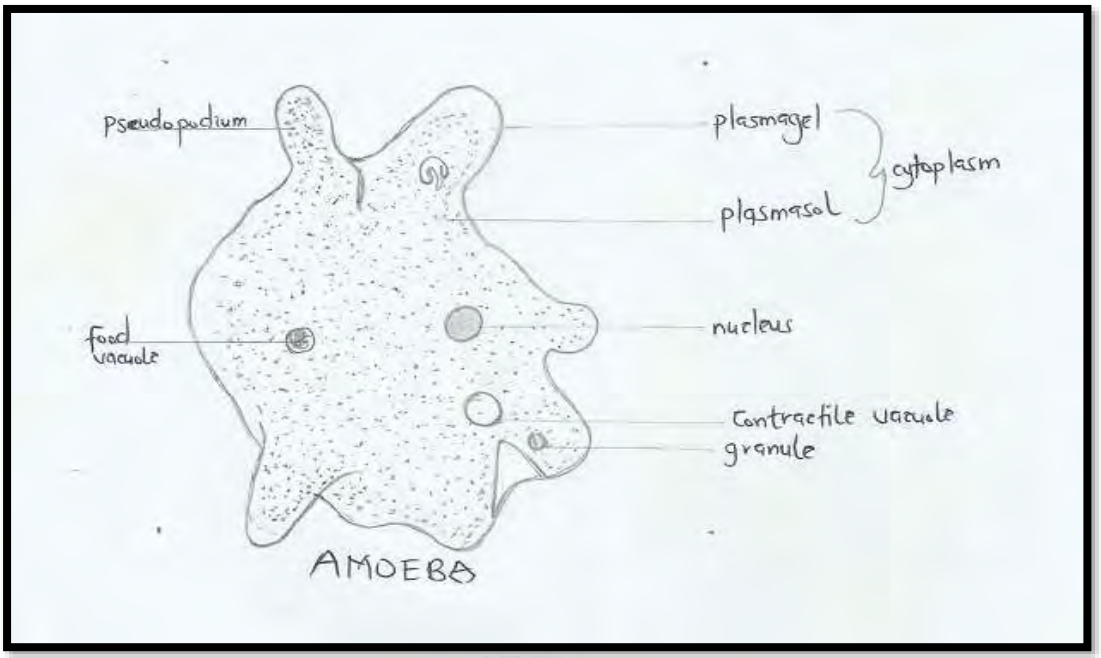

Figure 4.8: A Student (W14)'s drawing of Amoeba proteus without CAI

4.5 Analysis of students Exercise on Specimen Identification, Drawing and Labeling after Using Computer Assistance Learning

After using YouTube in teaching students how to draw, label and identify specimen, the students were tested again and the results shows that there was an improvement in the way students draw and label. The following are some of the scanned diagrams after the students were taught using you tube videos and the following improvements were observed:

1. There were no more shading. Students used dots to show dark areas.
2. Students were able to draw continuous lines. There were no more broken lines.
3. Students were able to make accurate drawing of the specimen.
4. The right pencils were used in drawing. There were no more pen for drawings.
5. Label lines were correctly drawn using a ruler, lines did not cross each other and it did not cross label names.

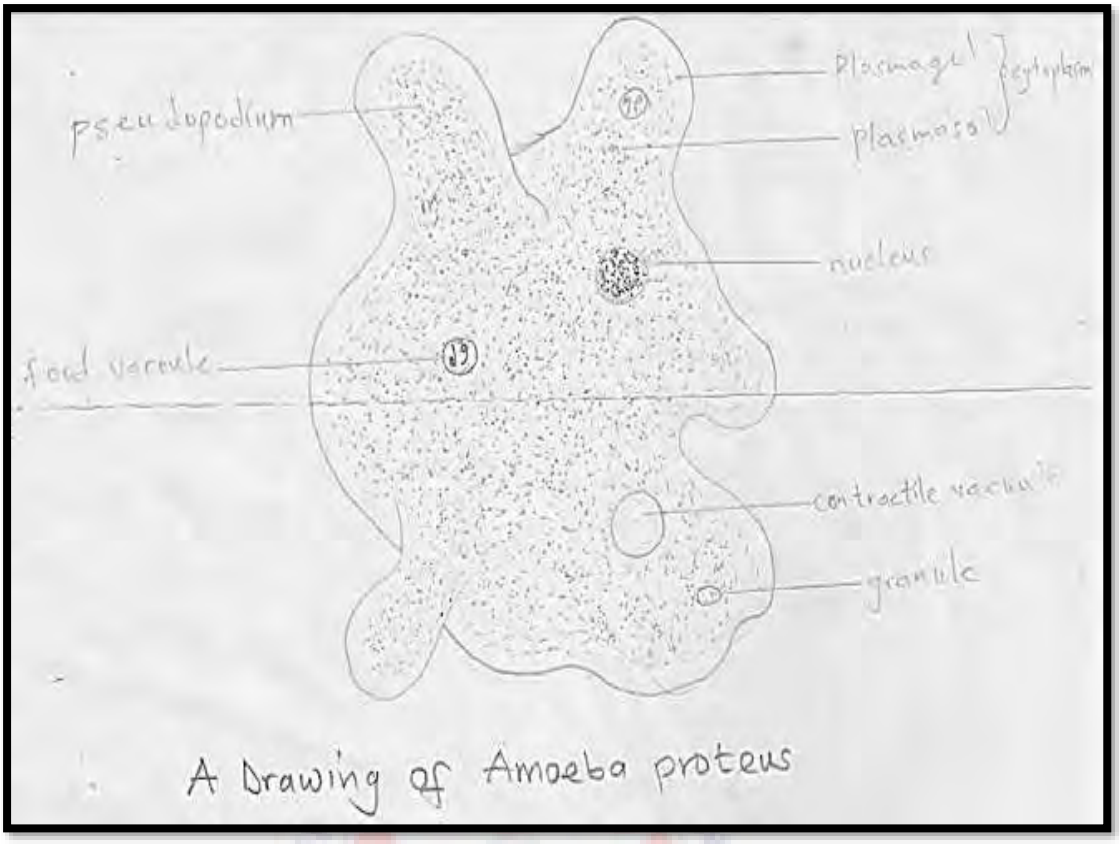

Figure 4.9: W10's Drawing of Amoeba Proteus after Using CAI

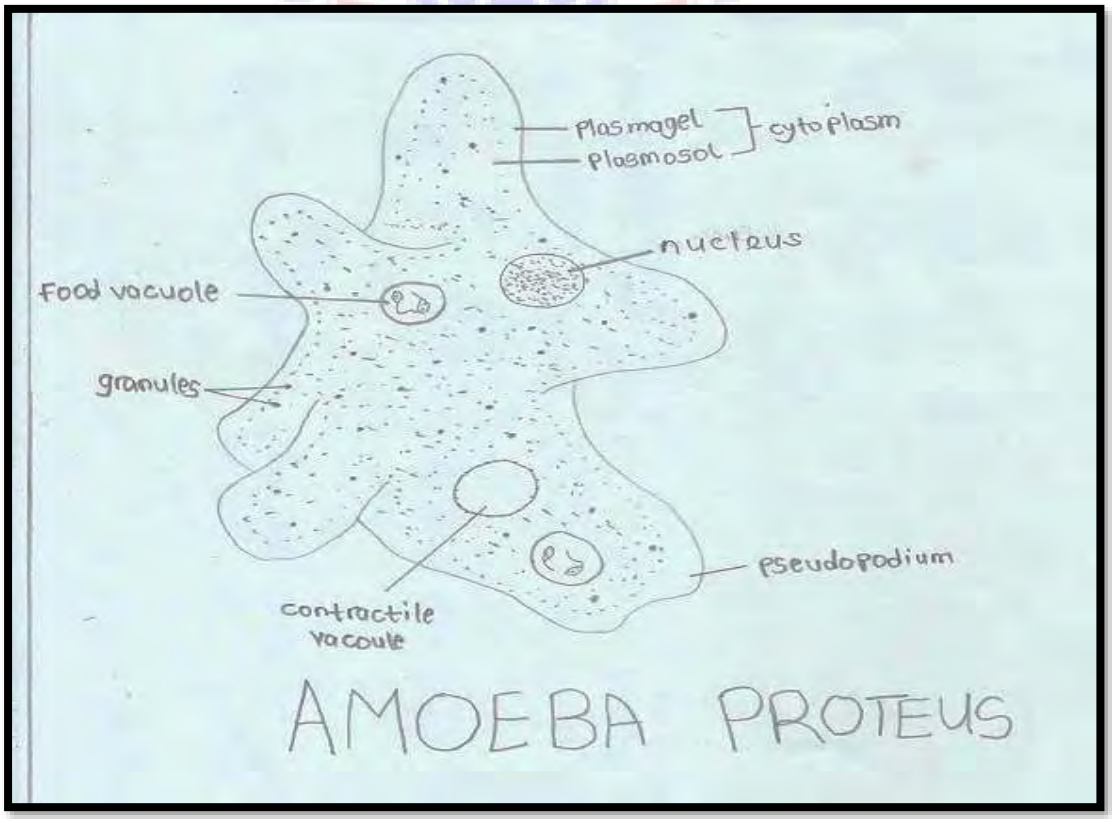

Figure 4.10: W11's Drawing of Amoeba Proteus after Using CAI

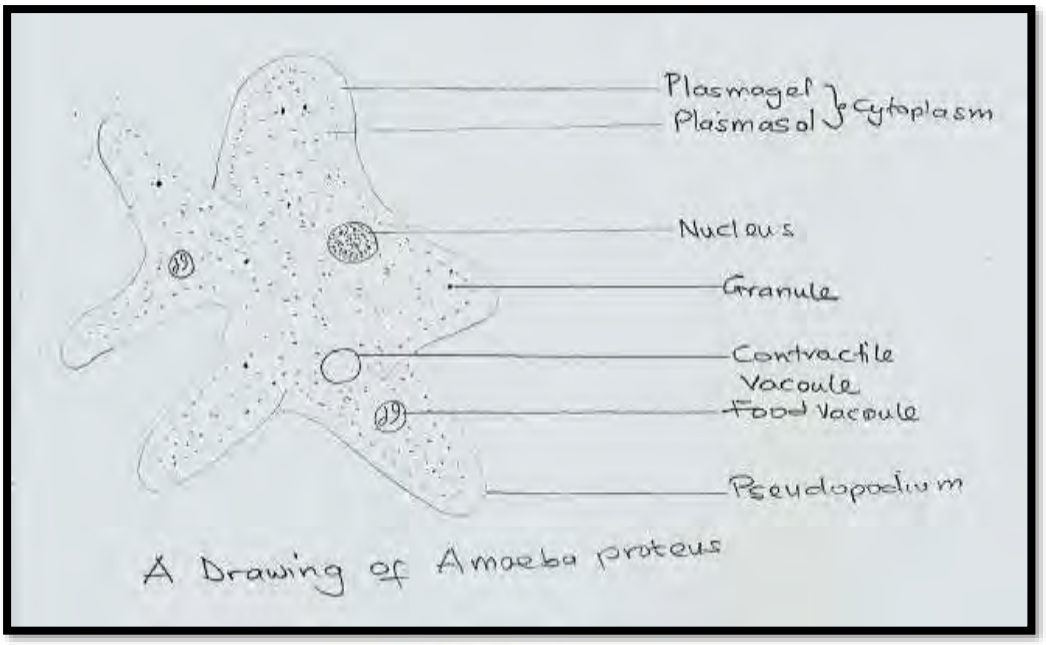

Figure 4.11: W12's drawing of Amoeba proteus after using CAI

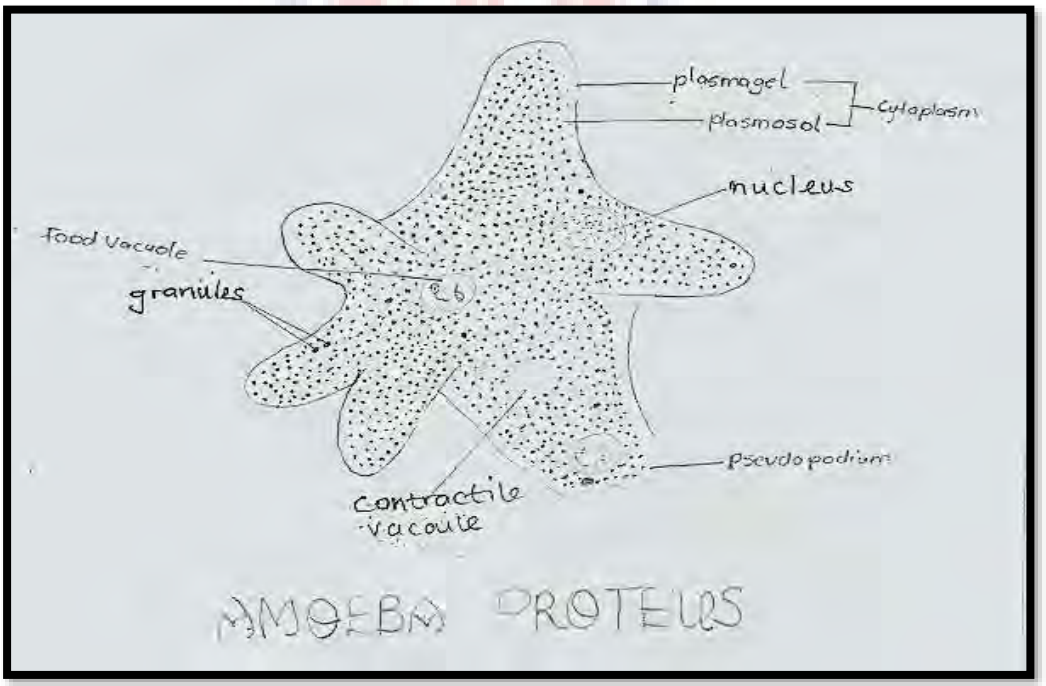

Figure 4.12: W13's drawing of Amoeba proteus after using CAI

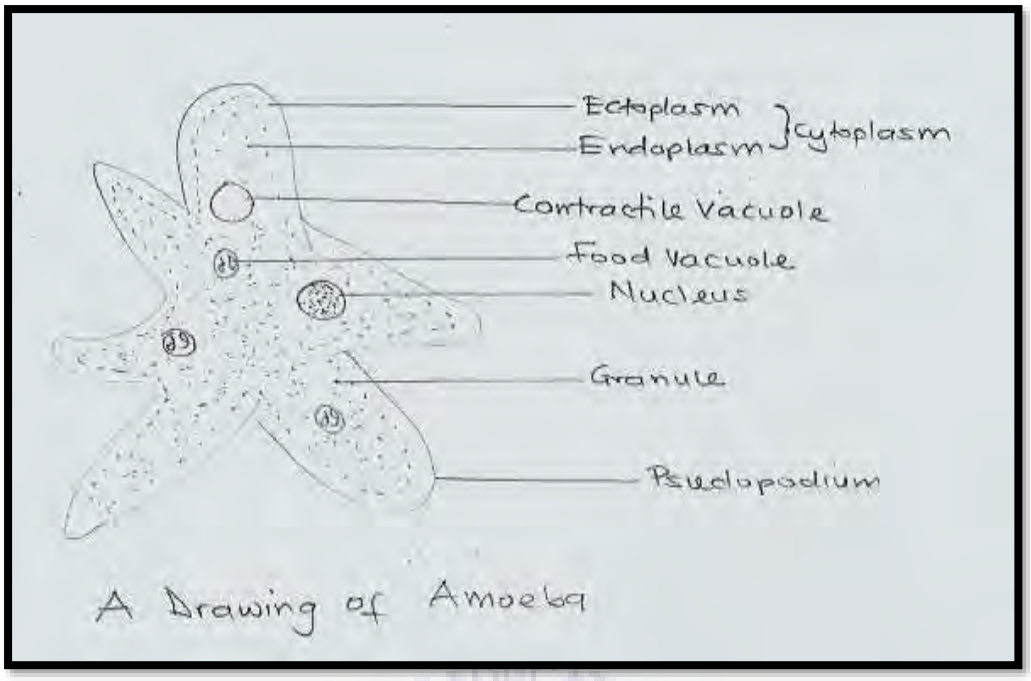

Figure 4.13: W14's drawing of Amoeba proteus after using CAI

4.6 Analysis of Pre-test and Post-test Results

The analysis of the pre and post- test results (Appendix V) and figure 4.14 showed that there was significantly greater difference between the mean comparison in the pre-test and post-tests with [$p < 0.5$]. The results from this study suggest that the impact of CAI on student learning is great. Students were able to acquire some identification, drawing and labeling skills, cognitive skills and general problem-solving skills through CAI. The results indicate that CAI is a more effective method for teaching student identification, drawing and labeling in biology.

W16 and W34 however did not show any improvement on their scores, their score for both pre and post-test were the same and this may be as a result of them not paying attention or it may be as a result of them not obeying simple rules.

Figure 4.14: A graph comparing mean marks of pre and post-test

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.0 Overview

The motive of using mixed-methods action research study in this research was to gain information about the use of CAI as a supplement to improve the traditional instructional way of teaching biological drawing, labeling and identification of specimen within a Senior High School to improve student achievement. This chapter includes a summary of the study results, the findings, conclusions and recommendations for practice, policy and future research.

5.1 Summary of Findings

The research questions answered in this study were:

1. What are the methods employed by teachers to teach identification of specimen, drawing and labeling in biology?
2. To what extent do students know the rules to be observed in the identification of specimen, drawing and labeling in biology?
3. What are the effects of computer- assisted instructions on student's ability to identify specimen, drawing and labeling the specimen?

In answering the research questions, a couple of instruments were used to analyze the data. Research Question 1 used questionnaire and interview. Research Question 2 also used questionnaire and interview. Research Question 3 also used questionnaire and interview in addition to a pre-test and a post-test.

5.1.1 The Findings: Research Question 1

Both quantitative and qualitative data analyses were used to analyze Research

Question 1 asked: What are the methods employed by teachers to teach identification of specimen, drawing and labeling in biology?

5.1.2 Method used in teaching specimen identification

A five Likert scale question was used to identify the methods employed by teachers' to teach students identification of specimen. These were lecture method, activity method, discussion method, computer- assisted method and not aware of the method. In looking at the comparison of the percentages, a large majority of the students answered that their teachers use the activity method in teaching them specimen identification. In comparing the percentages of students who chose activity method versus discussion method, a large majority of teachers at the senior high school level uses the activity method in teaching specimen identification. In comparing students who chose discussion method versus lecture method, majority of the students selected lecture method over discussion method. In comparing the three methods to computer-assisted instructions, it was realized that none of the student chose CAI. This implies that none of the teachers at the senior high school level uses CAI in teaching specimen identification. However, some few students were not aware of the method their teacher used in teaching them specimen identification.

5.1.3 Method used in teaching biological drawing

In analyzing this, five options were given to the students to choose from to help the researcher to detect the methods employed by teachers' to teach students how to make biological drawings. These were lecture method, activity method, discussion method, computer assisted method and not aware of the method. In looking at the comparison

of the percentages, a large majority of the students selected the activity method. In comparing the percentages of students who selected activity method versus discussion method, a large majority of teachers at the senior high school level use the activity method in teaching the students how to make accurate biological drawings. In comparing students who indicated discussion method versus lecture method, majority of the students selected lecture method over discussion method. In comparing the three methods to computer assisted instructions, it was realized that none of the student indicated CAI. This implies that none of the teachers at the Senior High School level uses CAI in teaching how to make good biological drawings. Nevertheless, some few students were not aware of the method their teacher used in teaching them how to make biological drawings.

5.1.4 Method used in teaching how to label biological drawings

Five options were given to the students to choose from to help the researcher identify the methods employed by teachers' to teach students how to label biological drawings. These were lecture method, activity method, discussion method, computer - assisted method and not aware of the method. Comparing the percentages of the results, a large majority of the students answered that their teachers use the activity method in teaching them labeling in biology. In comparing the percentages of students who picked activity method versus discussion method, a large majority of teachers at the senior high school level uses the activity method in teaching labeling. In equating students who indicated discussion method versus lecture method, majority of the students selected lecture method over discussion method. In comparing the three methods to computer- assisted instructions, it was realized that none of the student selected CAI. This implies that none of the teachers at the Senior High School

level uses CAI in teaching labeling. But, some few students were not aware of the method their teacher used in teaching them how to label biological drawings.

5.2 Research Question 2

In analyzing research Question 2: To what extent do students know the rules to be observed in the identification of specimen, drawing and labeling in biology? Both quantitative and qualitative data analyses were used to analyze Research question 2

The following findings were made:

- About 33% of the students at the senior high school level know the basic rules to be observed in the identification of specimen, drawing and labeling in biology.
- The results of the study indicate that majority of the students (67%) in senior high schools also lack drawing, labeling and identification skills. The results from the study also indicated that most students could not answer positively to the rules on identification of specimen, drawing and labeling. Drawing, labeling and identification of specimens enables learners to develop observational skills which helps them to relate structure to function, a problem experienced by most biology candidates at the national examination level.
- The researcher deduced that, the recommended practical approach in teaching of Biology is overlooked in syllabus coverage. This is the reason why majority of the respondents could not respond positively to the simple rules.
- Teachers did not inculcate in learners the skills which will enable them to relate structure to their function of the specimens.
- Lack of supervision and monitoring of students' practical work by biology teachers.

- ❖ Negative influence of wrongly drawn diagrams in charts and other sources.
- ❖ Carelessness and low aptitude on the part of the learners.

5.3 Research Question 3

In analyzing research Question 3: What are the effects of computer- assisted instructions on student's ability to identify specimen, drawing and labeling the specimen?

The Researcher used questionnaire and interview in addition to a pre-test and a post-test. A pre-test was administered to the sample after being taught how to identify specimen, drawing and labeling in biology using the traditional method. The sample was taught the same topic again using power point and videos from YouTube. After two weeks a post-test was conducted and a comparison of the two methods of instruction was analyzed by using paired t-test to interpreting the students' score differences for the pre unit test, post unit test.

The following findings were made:

1 All the students felt excited and many of them confirmed their excitement and lack of confusion whiles using power point and videos from YouTube.

2 Student's biological drawing, labeling and identification skills were improved from a mean score of 32% to 78%.

3 There was a significant difference between the scores of pre-test and the post-test. (Appendix VI and VII).

4 Many senior high schools do not have the required teaching learning materials for teaching specimen identification, biological drawing and labeling.

5 Some of the students at the senior high school level lack the basic skills in ICT.

5.4 Conclusions

The results gathered from the study specify that Computer-assisted instruction has significantly enhanced student achievement, given that, after the students were taught with CAI they performed far better than when they were taught using the traditional teaching methods. Student's average mark of 32% was significantly enhanced to 78% (Appendix VII) and (Figure 4.15). This clearly shows that Computer-Assisted Instruction has enhanced students 'knowledge levels positively and this was seen in the following areas:

- Students drawing skills were improved, in that, there were no more shading, there was a reduction in the use of wavy and double lines, the correct pencils were used and also students were able to make proportional drawings.
- Students labeling skills were also improved. Label lines were neatly drawn with rulers, label lines were no longer having arrow and label lines were not crossing each other.
- Student's identification skills were also improved, they were able to identify specimen easily and faster.

Therefore increasing the CAI opportunities in the classrooms will increase the academic achievement of students. The results also indicated that most students do not know the basic rules in drawing labeling and identification of specimen well, as most students could not answer simple questions on identification, drawing and labeling of specimens correctly. Mastery of drawing skills significantly affects performance in biology. Drawing of specimens enables learners to develop observational skills. This enables them to relate structure to function, a problem experienced in Biology by most candidates at national examination level. The study

concluded that; the knowledge students have on identification of specimen, biological drawings and labeling was poor and CAI can be used to improve it. Clinkscales (2002), recommended combining CAI with traditional instruction to provide the necessary instructional details provided by both methods. The CAI may be looked at more as a part of the content by the students in comparison to the students' perception and use of it in the recent study. The researcher believes that increasing the CAI opportunities in the classrooms will increase the academic achievement of students and therefore there is the need to educate all educational stake holders about the properties of CAI to enable them harness the benefits that come with their use for teaching and learning.

5.5 Recommendations

The following recommendations were made in the light of the findings revealed: Recommendations for Teachers

1. They should make themselves available to new technologies such as Computer- Assisted Instruction and other computer software in other to be abreast with time.
2. They should always be around to supervise students when they are using computers to learn because some students may do something else with the computer rather than learning

Recommendations for Ghana Education Service

1. Experts in Computer- Assisted Instruction from Ghana should be selected and sent to countries where this mode of instruction is utilized. This will upgrade their knowledge and help them make meaningful impact when they return.

2. There should be an introduction of Computer- Assisted Instruction in the curriculum of Colleges of Education to enable teacher- trainees to prepare their own software to teach various subjects.

Finally, to better gauge the impact on achievement and the perceptions of students on CAI, other software packages must be researched. Power point and the use of You Tube were the CAI of convenience being used at present in the school of study.

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APPENDICES

APPENDIX I

QUESTIONNAIRE

USING COMPUTER -ASSISTED INSTRUCTIONS TO IMPROVE STUDENTS' COMPETENCIES ON SPECIMEN IDENTIFICATION, BIOLOGICAL DRAWING AND LABELING.

Dear Respondent,

I am a Master of Philosophy (MPhil) student from the Faculty of Science Education at the University of Education, Winneba. I am conducting a research on the above topic. The objective of this research is to improve specimen identification, biological drawing and labeling competencies. This survey is meant for academic purposes, and will take about twenty minutes of your time. Please be assured that your responses will be treated with utmost confidentiality. Kindly respond to the questionnaire to the best of your ability. Thank you.

A. Personal Information

1. Form/Level: SHS 1 [ ] SHS 2 [ ] SHS 3[ ].

Research Questions

B. Students' Knowledge on specimen identification, biological drawing and labeling

1. What is specimen identification? .....

……

2. What method did your teacher use in teaching you how to identify specimen?

Lecture method [ ] Activity method [ ] Discussion method [ ] Computer assisted teaching [ ]

Others (Specify)…….……

3. What is Biological drawing? ……

4. What method did your teacher use in teaching how to make biological drawing?

   Lecture method [ ] Activity method [ ] Discussion method [ ] Computer assisted teaching [ ]

   Others

   (Specify)…….

5. What is labeling in biology? …….

   ……

6. What method did the teacher use?

   Lecture method [ ] Activity method [ ] Discussion method [ ] Computer assisted teaching [ ]

   Others (Specify)…….

Items	Strongly agree	Agree	Not aware	Disagree	Strongly Disagree
1. Any pencil can be used to draw in biology					
2. Only plain white paper can be used in drawings					
3. Erasers are allowed in biological drawings					
4. Pens can be used to draw on clean papers					
5. Diagrams should always be centered on the page					
6. Drawings should be large enough to easily represent all details visible under the microscope.					
7. Show only as much detail as necessary to represent the relevant features of the specimen.					
8. You do NOT have to draw everything.					
9. Drawings should accurately represent reality.					
10. If you see a complete oval in your specimen, your drawing should be a complete oval,					

Items	Strongly agree	Agree	Not aware	Disagree	Strongly Disagree
11. Proportions should also be accurate.					
12. You can draw from memory.					
13. Look at specimen for 5 seconds, then draw for 5 seconds. Repeat until finished.					
14. Never use shading.					
15. Never draw when you are not looking at the specimen.					
16. Labeling lines should always be made with a ruler					
17. Labeling lines should never cross.					
18. Keep labeling lines vertical or horizontal					
19. Leave a good margin for labels.					
20. Indicate title above drawing which accurately identifies the specimen					
21. Magnification should be below specimen (e.g., 100x)					
22. Indicate names of known or identifiable structures in margins, with lines connecting the structures to their labels					
23. Part of an organism can be used for identification					

C. Rules in specimen identification, drawing and labeling in biology

Items	Strongly agree	Agree	Not aware	Disagree	Strongly Disagree
24. Identification provides a stable and universal vocabulary of an					
25. Each specimen should be tagged with a correct identification					
26. Identification should be both machine and human readable					
27. Identification must be unique within a collection					
28. Identification may contain additional information					
29. The dichotomous key is a common tool used by biologist for identification					
30. Identification methods may be manual or computerized					

APPENDIX II

OBSERVATIONAL CHECK LIST

Type of pencil used	HB/2H	Pen / others
Type of paper used	Plain	Ruled
Making label lines	Those using ruler	Those using free hands
On their work	Those working independently	Those seeking help from others
	Neat drawing	Dirty drawing

APPENDIX III

INTERVIEW GUIDE FOR STUDENTS

1. What pencil do you use in making drawings in biology?
2. What kind of paper do you use when making drawings in biology?
3. Are you allowed to use eraser in biological drawings?
4. Can Pens be used to draw on clean papers?
5. Where should your diagrams be on the paper?
6. Should drawings be large enough to easily represent all details visible under the microscope or drawings should be small?
7. Is it necessary to show only as much details to represent the relevant features of the specimen?
8. Do you have to draw everything you see?
9. Drawings should accurately represent reality, do you agree or disagree? Explain.
10. If you see a complete oval in your specimen, should your drawing be a complete oval?
11. Do you have to take proportions into consideration when drawing?
12. Can you draw from memory?
13. Look at specimen for 5 seconds, then draw for 5 seconds. Repeat until finished. Explain.
14. Is shading allowed in biological drawing?
15. Never draw when you are not looking at the specimen, true or false? Explain.
16. Should labelling lines always be made with a ruler?
17. Can labelling lines cross each other?
18. How can labeling lines be made? Vertically or horizontally?

19. Is it important to leave margins for labels?
20. Are titles important in biological drawing? How should it be written?
21. What is magnification? How do you calculate it and how is it written?
22. Indicate names of known or identifiable structures in margins, with lines connecting the structures to their labels.
23. Can part of an organism be used for identification?
24. Identification provides a stable and universal vocabulary of an organism. Do you agree or disagree.
25. Is it necessary to tag each specimen with a correct identification?
26. Identification should be both machine and human readable. What do you have to say?
27. Identification must be unique within a collection. True / false?
28. Should identification contain additional information?
29. What do you know about the dichotomous key, a common tool used by biologist for identification?
30. How should identification methods be? Manual or computerized?

APPENDIX IV

EXPECTED ANSWERS FOR THE INTERVIEW

1. HB pencil or 2H pencil

2. Plain sheets

3. Yes

4. No

5. Center or left hand corner

6. Drawing should be large

7. Yes

8. Yes

9. Agree

10. Yes

11. Yes

12. No

13. You should picture the specimen in your mind before drawing.

14. No

15. True

16. Yes

17. No

18. Horizontally

19. Yes

20. Titles are very important in biological drawing, it should be written below the drawing.

21. Magnification is the ratio of the length of the drawing to the length of the object/ specimen. It is written at the right hand side of the drawing. (e.g. × 9).

22. True

23. No

24. Agree

25. Yes

26. Yes

27. Agree

28. yes, identification may contain additional information

29. It is a method used to identify specimen.

30. Both manual and computerized

APPENDIX V

PRE-TEST AND POST-TEST

Pre-test

1. Identify specimen A.

2. Make a well labelled diagram of specimen A and label its parts.

Post-test

1. Identify specimen A.

2. Make a well labelled diagram of specimen A and label its parts.

APPENDIX VI

Paired T-Test and CI: PRE-TEST, POST-TEST

Paired T-test for Pre-Test and Post-Test

	Number of respondents	Mean	Standard deviations	Standard Error Mean
Pre-test	35	3.200	1.132	0.191
Post -test	35	7.800	1.132	0.191
Difference	35	-4.600	1.649	0.279

95% CI for mean difference: (-5.166, -4.034)

T-Test of mean difference = 0 (vs ≠ 0): T-Value = -16.51 P-Value = 0.000

APPENDIX VII

PRE-TEST AND POST-TEST COMPARISON RESULT

Respondents	Pre-test				Post-test			
	Marks(x)	Mean(X)	(x-X)	(x-X)2	Marks(x)	mean(X)	(x-X)	(x-X)2
W1	4	3.2	0.8	0.64	8	7.8	0.2	0.04
W2	3	3.2	-0.2	0.04	8	7.8	0.2	0.04
W3	4	3.2	0.8	0.64	9	7.8	1.2	1.44
W4	5	3.2	1.8	3.24	7	7.8	-0.8	0.64
W5	2	3.2	-1.8	1.44	7	7.8	-0.8	0.64
W6	2	3.2	-1.8	1.44	8	7.8	0.2	0.04
W7	1	3.2	-2.2	4.84	6	7.8	-1.8	3.24
W8	3	3.2	-0.2	0.04	8	7.8	0.2	0.04
W9	3	3.2	-0.2	0.04	9	7.8	1.2	1.44
W10	4	3.2	0.8	0.64	9	7.8	1.2	1.44
W11	2	3.2	-1.8	1.44	8	7.8	0.2	0.04
W12	1	3.2	-2.2	4.84	8	7.8	0.2	0.04
W13	3	3.2	-0.2	0.04	8	7.8	0.2	0.04
W14	2	3.2	-1.8	1.44	8	7.8	0.2	0.04
W15	1	3.2	-2.2	4.84	7	7.8	-0.8	0.64
W16	5	3.2	1.8	3.24	5	7.8	-2.8	7.84
W17	5	3.2	1.8	3.24	9	7.8	1.2	1.44
W18	4	3.2	0.8	0.64	8	7.8	0.2	0.04
W19	4	3.2	0.8	0.64	7	7.8	-0.8	0.64
W20	4	3.2	0.8	0.64	7	7.8	-0.8	0.64
W21	3	3.2	-0.2	0.04	8	7.8	0.2	0.04
W22	3	3.2	-0.2	0.04	9	7.8	1.2	1.44

W23	5	3.2	1.8	3.24	8	7.8	0.2	0.04
W24	4	3.2	0.8	0.64	7	7.8	-0.8	0.64
W25	3	3.2	-0.2	0.04	7	7.8	-0.8	0.64
W26	3	3.2	-0.2	0.04	8	7.8	0.2	0.04
W27	2	3.2	-1.8	1.44	9	7.8	1.2	1.44
W28	4	3.2	0.8	0.64	8	7.8	0.2	0.04
W29	4	3.2	0.8	0.64	9	7.8	1.2	1.44
W30	4	3.2	0.8	0.64	8	7.8	0.2	0.04
W31	3	3.2	-0.2	0.04	9	7.8	1.2	1.44
W32	2	3.2	-1.8	1.44	8	7.8	0.2	0.04
W33	3	3.2	-0.2	0.04	8	7.8	0.2	0.04
W34	4	3.2	0.8	0.64	4	7.8	-3.8	14.44
W35	3	3.2	-0.2	0.04	9	7.8	1.2	1.44
Total	112				273			