UNIVERSITY OF CAPE COAST

INVESTIGATING THE PERFORMANCE OF SENIOR HIGH SCHOOL STUDENTS IN BIOLOGY PRACTICAL WORK

EMELIA SERWAA-AMPAAFO

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BY

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DECLARATION

Candidate's Declaration

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

Candidate's Signature …… Date……

Name: Emelia Serwaa-Ampaafo

Supervisors' Declaration

We hereby declare that the preparation and presentation of this thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

Principal Supervisor's Signature…… Date……

Name: Prof. Theophilus Aquinas Ossei-Anto

Co-Supervisor's Signature…… Date……

Name: Dr. Christopher Beccles

ABSTRACT

This study was carried out to investigate the performance of senior high school students in biology practical work in the Ledzokuku Municipality of the Greater Accra Region of Ghana. The mixed method approach was used and the design used was sequential explanatory design. A sample of 90 senior high school form 2 (SHS2) elective biology students randomly drawn from three public senior high schools were used for the study. The study was guided by three research questions and two research hypotheses. The Biology Practical Performance Test (BPPT) developed by the researcher and semi-structured interview guide were used for the data collection. The data collected were analyzed using mean, standard deviation, Analysis of Variance (ANOVA) and independent sample t-test at 0.05 level of significance. The results of interview were transcribed and analyzed thematically. The results showed that majority of the elective biology students performed below average in biology practical test. It was also seen that there was a significant difference in the performance of students in the tasks assigned to students during practical work. It was seen that students performed above average in Habitat task, averagely in Observation task and below average in Adaptation task, Drawing task and Classification task. The study also showed that there is no significant difference in the performance of males and females in biology practical work as measured by the Biology Practical Performance Test (BPPT). It was recommended that biology teachers should take students through a lot of practical activities to help improve students' performance in practical work.

KEY WORDS

Performance

Practical work

Biology

Task

Gender

Level

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DEDICATION

To my sisters, Emmanuella, Christiana, Agnes and Esther

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LIST OF ACRONYMS

SRC	Science Resource Center
WASSCE	West African Senior Secondary Certificate Examination
SEEP	Science Education Empowerment Project
SHS	Senior High School
GES	Ghana Education Service
MoE	Ministry of Education
WAEC	West African Examination Council

CHAPTER ONE

INTRODUCTION

Overview

The chapter contains information on the background to the study, statement of the problem, the purpose of the study, educational significance of the study and the research questions and hypothesis addressed by the study. Also presented are the limitations and delimitation of the study. The chapter ends with the presentation of the operational definitions of terms used in the study as well as a description of the organization of the study.

Background to the Study

In the history of education, science has held its leading position among school subjects because it is considered as an indispensable tool in the development of the educated person. The word "science" is often misconstrued by many people. While some see it as a white man's "juju", others interpret it as a kind of magic. Like the three blind men who went to see the elephant, many people who attempt to define science make valid but fragmentary definition of it. Little do people realize that many of man's daily activities involve doing science.For example, when a stick of match is struck, science is being done. When yeast is added to flour to make it rise, science is being done. The barber also does science when he applies soap solution to his customer's hair to make it soft. Thus, science is not magical as some people think but science is all around us.

Ofuebe (2007) defined science as a dynamic human activity concerned with understanding of the working of our world. Ali (2002), also believed that the word 'science 'stands for a variety of information, abilities and operations

about the natural environment. He believes that science is more concerned with various investigative processes and activities with regards to developing, acquiring and controlling knowledge, skills, capabilities and attitudes about the natural factors of the environment. Aniodoh(1991) also viewed science as "a body of knowledge arrived at through systematic and procedural processes based on tentative observations and experiment" (p.50). In the sight of the above, science may be seen as a way of thinking in the pursuit of understanding nature, a way of investigating and a body of established knowledge. Ambuno, Egunifomi, and Osakwe (2008) noted that, without science, the world today would not have been what it is. Technological advancement has completely changed the world. This has permeated all aspects of human lives which include communications, health, agriculture, building etc. Exploration of the earth and improvement in conditions of living in our homes, schools, roads etc.are all based on science in terms of modern equipment and materials. In fact, with the world changing very fast as a result of human activities and population growth, what may save our planet earth is scientific inquiring for solutions to prevailing problems and those we may face in the future.Hence the necessary attention given to its studies in schools all over the world.

According to Norris (1992) the aims of science education in schools include "helping students to gain an understanding of the established body of scientific knowledge and to develop students' understanding of the methods by which this knowledge has been gained". (pp 28-30).

Educators give special recognition to biology among the sciences because of its educational values, its close relation to man as a living thing, its

peculiar field of experimentation and interrelationships with the other sciences (Akinmade, 1997). As a result of this, biology occupies a relatively pivotal position in the natural sciences and it is one of the requirements to professions such as medicine, pharmacy, agriculture, dentistry, microbiology, biotechnology, nursing and many others. It is for this reason that Bibby (2004), advocated for adequate biology education for every child in the contemporary world dominated by science.

Biology has remained the most popular subject in the senior high school System in Ghana (Anamuah-Mensah, 1995). It has a high enrolment figure annually compared to chemistry, physics and the other science subjects.However, this number does not reflects the students' achievement in the subject. Since the introduction of biology into the senior secondary school (SSS) programme as one of the sciences, students' performance in biology examinations conducted by the West African Examination Council (WAEC) has been dwindling despite the numerous educational reforms, policies and programs (Science Resource Center Project, USAID Science Project and SEEP Project) initiated by the Ghana Education Service (GES) and the Ministry of Education (MoE) to improve the teaching and learning of the subject in the country (Anamuah-Mensah, 1995).

According to Nnamonu (2003), and Akinmade (1992) in spite of these policies by educational authorities to improve teaching and learning, students' performance has consistently been below expectation and unimpressive. Similarly, the Chief Examiners' Reports from the West African Examination Council (WAEC) have consistently indicated poor performance of SHS students in biology (WAEC, 1994; 1995; 1996; 2002; 2003; 2004; 2005, 2010,

2011, 2012, 2013, 2014, 2015). The Chief Examiners' Reports showed that more students fail in biology because they do not perform creditably in biology paper 3, which is a practical paper. This gives the impression that the students were either not taken through practical work at all or were not serious with the practical work.

Some weaknesses identified by the Chief Examiner over the years (1994-2015) for biology practical are as follows:

1. Candidates' answers show that they had not been taken through adequate practical work.
2. Students' answers indicated that they had not done any biology practical work along the lines of the tested questions.
3. Candidates wrote unobservable features. Thus they answered the practical questions from the theory's version.
4. The standard of students' drawings was poor. This indicated that they did not practice biological drawing as required by the biology practical examination.

With these weaknesses in mind, it is of great interest to find out the level of students' performance in the various tasks (questions) along which they are tested during the WASSCE biology practical paper (Biology paper 3).

Akinmade (1997) reported that on the average 78.8 % of the students who sat for the West African Secondary Schools Certificate Examinations (WASSCE) failed biology because they failed the practical paper (paper 3) and the situation is not different in Ghanaian schools. For this reason, in recent times there has been public outcry on the declining standard of science education, especially in the area of biology. In addition, the scores or marks

(80marks) allotted to practical examination is higher than those of objectives test (50marks) and essay test (70marks). This proves that, the inability of a student to perform better in the practical paper affects the entire grade of the student.From the foregoing, it can be understood that the need to find out how students perform in the various tasksduring biology practical examination is obvious and of great concern since the marks obtained in the practical paper to a large extent determine the grade of the students in the entire biology paper.

Biology being a branch of science involves the study of living and non-living things (Sarojini, 2001). Similarly, Johnson (1995) defined biology as the scientific study of living things. Abugu (2007) defined biology as a natural science in which we study living organisms – plants and animals. Furthermore, Iloeje (2007) viewed biology as the science in which we study living things.

Traditionally, biology is divided into two branches: botany, the study of plants and zoology; the study of animals. Some of the importance of biology education cited by Sarojini (2001, p.195-200) included:

1. it helps in scientific research and development of new tools and techniques which invariably improves the quality of our lives,
2. It helps in finding applications in medicine, dentistry, veterinary science, agriculture and horticulture;
3. Helps in biotechnology which includes fields like genetic engineering and hybrid technology
4. It helps in dealing with ecological problems such as over population, food shortage, erosion, pollution, disease etc.

The importance accorded science, and for that matter biology, in the school curriculum from the basic level to the senior high level reflects

accurately the vital role played by the subject in contemporary society. The importance of the subject is not restricted to the development of the individual alone but for the advancement of the social, economic and political goals of countries all over the world. Hence any hindrance to the students' performance in biology must be dealt with so that this backwardness in biology examinations can be reversed.

Like other science subjects, biology in secondary schools is composed of practical activities. Practical work in biology is considered according to Iloeje (2007), as part of the study of biology that involved field work, observing, collection and laboratory study of specimens, drawing diagrams and conducting experiments. The 2010 elective biology syllabus emphasized that instructional strategies in biology should be practical base to enable learners appreciate biology as a process. The justification for practical work in biology at the Senior High School level is supported by the aims of practical biology in the West African Examination Council Syllabus as follows:

1. To understand the structure and functions of living organisms as well as to appreciate nature
2. To acquire adequate laboratory and field skills in order to carry out and evaluate experiments and projects in biology
3. To acquire necessary scientific skills, for example, observations, classification and interpretation of biological data
4. To be able to interpret and illustrate knowledge of biology principles and to develop the ability to perform simple experiments and makes inferences from the results established.
5. To acquire scientific attitude for problem solving

6. To be able to apply biological principles in everyday matters that affect personal, social, environmental, community health and economic problems. It is of great importance in order to achieve the above objectives that there should be effective teaching and learning of biology practical work.

Eze (1999) stated that practical was very necessary in the teaching of biology but it was unfortunate that some teachers deliberately refused the use of practical work in teaching and this has increased the poor performance of students in biology practical examinations.

A lot of research on WASSCE biology practical has been done. Obidiwe (1992) and Serwaa (2007) identified a number of factors as responsible for this poor performance of students in biology practical examinations. The major factor according to chief examiner's report (2005,2011, and 2013,2014, 2015) was the students' inability to perform the tasks assigned to them during the biology practical examination (biology paper 3)

The WASSCE biology practical paper (biology paper 3) is a two (2) hour paper consisting of three (3) questions of which students are expected to answer all questions. The biology practical paper tests students' understanding and skills in these tasks: drawing, observation, classification, adaptation, analysis of some life processes and economic importance of some organisms.

Therefore, when students' performance in these tasks are assessed through a number of test and tutorials conducted by their teachers during their biology practical lessons, teachers can sometimescome out with various interventions that will help remedy this problem of students' poor performance

in biology practical examinations. Therefore, assessing students' performance in these tasks is a critical factor worthy of investigation.

In the light of the above, there is a great need to find out the level of students' performance in the various tasks assigned to themduring biology practical work in order to find out which tasks they performed better inand the ones they performed poorly in so as to help curriculum developers and teachers to come out with interventions that will help improve the students' performance in these tasks. Also the performance of males and female's students in each of the practical task was also compared to determine whether there is a significant difference in performance.

Statement of the Problem

Practical work is a vital aspect of the biology curriculum at the senior high school level that finds prominence in all biology examination. Biology students do not perform creditably in the biology practical examination. It has constantly been pointed out in the Chief Examiners report (2005, 2009, 2010, 2011, 2012, 2014,2015) that biology students perform poorly in the biology practical examination (biology paper 3). According to the report, students' answers show that they had not been tested in any of the tasks that students were tested on during the WASSCE biology practical examination.

It was on this weakness that this research seeks to investigate the level of students' performance in the various practical tasks SHS students were tested on during the WASSCE biology practical paper (Biology Paper 3).

Purpose of the Study

The main purpose of this study was to investigate the level ofstudents' performance in the various tasks in the biology practical examination the students were tested on during the WASSCE biology practical paper. The study also aimed at comparing the performance of males and females' students' in the various practical tasks that were assigned to them during the biology practical work.

Research Questions

The study sought answers to the following research questions

1. What is the performance of senior high school biology students in biology practical work?
2. What are the mean scores of students in each of the biology practical task in each of the four test?
3. To what extent does the mean scores of male students in the biology practical tasks in the tests different from those of the female students?

Research Hypotheses

1. Ho: There is a significant difference in the mean scores of students in the biology practical task assigned in each of the four tests.
2. Ho: There is a significant difference in the mean scores of male students and female students in the biology practical tasks in the four tests.

Significance of the study

The benefit of this research cannot be over emphasized. It would help erase the negative impressions that students have toward the studying of biology in general and biology practical in particular which discourages them

from pursuing biology into higher level of academia. This is because students' frequent exposure to different practical lessons and the motivation derived from successful completion of tasks in practical lessons will help improve their performance. Innovative approaches to the teaching of biology and its practical lessons by teachers would prepare students mind adequately and confidently towards the development of positive attitude and interest towards biology practical work and biology as a whole. This would help increase the performance of students wishing to pursue biology and science as a whole in the secondary level and after secondary school education.

Furthermore, this study would enable students to give serious attention to practical activities after knowing their performance. This will help them discover new ideas and knowledge for themselves as learning becomes students oriented allowing them to go through series of activities themselves. This would enable them to apply concept being learned in school to their everyday life activities within their environment.

Furthermore, innovative practical lessons would enable students to easily recall concepts learned, develop their higher thinking skills as well as communicative skills thereby increasing examination results of students. This will further increase the uptake of science and biology students into tertiary institutions. This will also help increase the performance of science students in higher level of academia.

Also science teachers would recognize that the nation's economic future depend fully on biology and science and its practical activities, therefore, if more attention is given to practical lessons, the technological development of the country would be put on a high potential. This will

motivate teachers to direct their knowledge, efforts and skills to practical lessons despite any obstacles that might hinder them from organizing such practical lessons. The study would also help biology teachers to come out with innovative interventions that will help students in understanding biological concepts.

In addition,the study would also give useful information to the Ministry of Education, curriculum developers and other educational authorities to undertake interventions to promote practical lessons in biology and science as a whole within senior high schools in the country. Furthermore, the understanding of students' performance has the potential to benefit educational policy makers in helping to encourage the teaching and learning of science as a whole to better suit the needs of the students. The study would also bring into light the problems and difficulties faced by both teachers and students during biology practical lessons so that the necessary action is taken by students, teachers, school authorities, Ghana Education service, Ministry of Education, Non-governmental organization and stakeholders of education to help solve them. Indeed, Cook-Sather (2002) wrote, "there was something fundamentally amiss about building and rebuilding an entire system without consulting at any point those it was ostensibly designed to serve" (p.5). Thus, by beginning to understand the performance of those students that biology practical work concerns, biology lessons and biology uptake may be better comprehended. Additionally, the findings could augment the pool of data required by other educational researchers in their bid to design interventions to solve educational problems in the sciences in general and biology in particular.

Finally, this study would serve as a basis for further research work to any researcher willing to do so.

Delimitations of the study

The study was delimited to only five tasks in the biology practical work. These tasks are observation (observable features), adaptation (adaptive features), classification, habitat and drawing. These tasks were considered because they are frequently asked in almost every biology practical examination. The study was also delimited to only SHS two elective biology students within the Ledzokuku municipality.

Limitations of the study

Most students at the time the test was conducted had not been taught some of the topics used for the test and this affected their performance in the test.The time allocated for the completion of each test (30minutes) did not allow some students to complete the test. This also affected their performance. Some students absenting themselves from school during the day of sampling also affected the sample size of the study.

Definition of Terms

Performance: How well or badly a person does a particular activity

Level: A particular standard of skill or ability

Practical work: Any teaching and learning activity which involves at some point the students in observing or manipulating real objects and materials.

Sex: The fact of being male or female

Organization of Study

This study report is presented under five chapters. Chapter One deals with the background of the study, statement of the problem, purpose of the study, research questions, significance of the study, delimitation of the study, limitation of the study, definition of terms and organization of the study.

The review of the relevant literature on the study forms the Chapter Two with the Chapter Three dealing with the methodology. This comprises of the approach and design of the study, population, sampling and sampling techniques used, Research instrument and data collection procedure as well as the procedure for analyzing the data.

Chapter Four, dealt with the presentation of results,the discussion of the findings and ended with summary of the major findings.Lastly, Chapter Five dealt with Summary, Conclusions and recommendations.

CHAPTER TWO

LITERATURE REVIEW

Overview

This chapter contains the review of the literature related to the study. It also contains the theoretical frame work related to the important aspect of the study. The chapter contains History of practical work in science, meaning ofpractical work in science andnature of biology practical work. Also present in this chapter are available resources for biology practical work, role of practical work in teaching and learning of biology and performance of students' in biology practical work in secondary schools. The chapter ended with the effects of practical work in the performance of students in Biology.

History of practical work

Although the value and purpose of practical work has been continuously debated, it has nevertheless remained a core component of school science education. Indeed, the inclusion of practical work within an academic subject is a significant feature that distinguishes science from the majority of other subjects in secondary schools. The use of practical work in Ghanaian Science Educationis clearly recognized as important aspect of the educational curriculum (biology, physics and chemistry syllabi for Senior high schools 2010) yet it remains rather atypical interms of the quantity and amount of time devoted to it compared to some other countries (Bennett, 2005; Woolnough,1998).

For most teachers, practical work encompasses what teaching and learning scienceis all about (Woodley, 2009). However, there is a growing debate surrounding the effective and affective value practical work has on

students and their learning (Abrahams, 2009; Abrahams & Millar, 2008; Hodson, 1991).

In the world today, it appears difficult to speak of science education without considering practical work. As Abrahams and Millar (2008), indicate, many teachers view practical work "as central to the appeal and effectiveness of science education" (p. 194). Indeed, reference is often made to the adage, 'I hear and I forget, I see and I remember, I do and I understand' written originally by Confucius.

However, Driver (1983) explained how doing practical work does not always indicate progression in learning science. Indeed, practical work does notal ways produce the results or the phenomena desired by the teacher. This then has the potential to either confuse or disengage students as they may begin to think either that the theory is in correct or that the practical is providing them with incorrect or contradictory result to those predicted by scientific theory. This then shapes the adage,"I do and I am even more confused" (Driver, 1983, p. 9). Despite all the debates about the effective value of practical work, yet it continues to be integrated into science lessons. It has been suggested that teachers find using practical work to be a method of behavior management (Wickman, 2002). Thus, practical work may not consequently be used to effectively enhance the learning process for students (Abrahams & Millar, 2008). Furthermore, there may be possible implications on students' decisions to continue with science after secondary school education from this use of practical work.

Meaning of Practical Work in School Science

There is confusion in the broader science education community about the definition of "practical work". This confusion makes discussions about the value of "practical work" difficult. A variety of terms exist to describe practical work, many of which are frequently used with little clarification. For example, Science in the National Curriculum uses several terms with little attempt to explain their meaning: 'Practical and enquiry skills', 'practical and investigative activities', 'independent enquiry' and 'experimental work' (Qualification and Curriculum Authority 2007a/b).

Science Community Representing Education (SCORE) (2008) also defined practical work as any science teaching and learning activity which involves students, working individually or in small groups, manipulating and/or observing real objects and materials, as opposed to the virtual world. Also, Science Community Representing Education (SCORE), (2009a) produced a framework for practical science in schools defining practical work in science as 'a "hands-on" learning experience which prompts thinking about the world in which we live'. An associated report of SCORE, SCORE (2009b), considered two main categories of activities that are considered as practical work. These categories are:

Core activities which include investigations, laboratory procedures and fieldwork. These hands-on activities support the development of practical skills and help to shape students understanding of scientific concepts and phenomena.

Direct related activities which include teacher demonstrations, experiencing phenomena, designing and planning investigation, analyzing

results and data analysis using ICT. These activities are either a key component of an investigation or provided valuable first-hand experiences for students.

In addition, some argue that other activities such as use of computer simulations, modellings, use of surveys, presentations, group discussion and role play can also constitute what is meant by the term practical activity (SCORE,2008). However, others disagree and believe these activities would not come under the practical activity 'umbrella' and rather they should be used complementarily alongside other practical activities, rather than be a substitute for them (Woodley, 2009)

Wellington (1989) also noted that there were 'at least six types of activities' that took place in school science 'that could probably be classified as practical work' (p. 12):

1. teacher demonstrations; class practical with all learners on similar tasks,
2. working in small groups
3. a circus of 'experiments' with small groups engaged in different activities,
4. rotating in a carousel
5. investigations
6. problem-solving activities.

According to Gott and Duggan (1995), these different types of activity have different purposes but as Wellington also pointed out, many 'experiments' were nothing of the sort because no new knowledge was being created.

Nzewi (2008), asserted that practical activities can be regarded as a strategy that could be adopted to make the task of a teacher (teaching) more real to the learners as opposed to abstract or theoretical presentation of facts, principles and concepts of subject matters. Laboratory experiments (activities) are characteristics features of science teaching at all levels of education (Adane &Adams, 2011)

Abel and Lederman (2007), authors of the Handbook on Research on Science Education, also provided what they called classical definition of school science laboratory activities (practical activities) as learning experiences in which students interact with materials or with secondary sources of data to observe and understand the natural world. For example, aerial photographs to examine lunar and earth geographic features; spectra to examine the nature of stars and atmospheres; sonar images to examine living system. (Lunetta, Hofstein & clough, 2007).

The views of current practitioners and other stakeholders on their definition of practical work were also explored through questionnaires submitted during stakeholder workshops. The questionnaires endeavored to identify what teachers considered to be practical work in terms of specific activities rather than overarching statements. Both the primary and secondary survey respondents were offered a list of 13 different types of activity. Two of these: investigations and fieldwork were almost unanimously accepted as being seen as practical work. Also receiving majority support for inclusion were: laboratory procedures and techniques, collecting and analyzing data using IT, designing and planning an investigation- though there are significant differences between primary and secondary responses.

Those offering individual views mentioned similar activity categories in answer to the question: what do you consider practical work to be? The individual responses ranged from the inclusive: doing things with stuff (as quoted by a 11year-old boy), anything not theory to be specific: building instruments (meteorologist) and showing the distinctive nature of the different sciences and giving career orientation (pharmacologist). Other individual correspondent also concentrated on processes rather than activities and the questionnaire respondents agreed with this approach. Around half approved of designing and planning, data collection (including using ICT), analyzing and evaluating.

In a report written for the US National Academy of Sciences, Robin Millar pointed out that when using the term *'practical work'* he referred to 'any teaching andlearning activity which at some point involved thestudents in observing or manipulating the objects and materials they were studying' (Millar, 2004, p. 2). By way of explanation, Millar added:

> "I use the term 'practical work' in preference to 'laboratory work' because location is not a critical feature in characterizing this kind of activity. The observation or manipulation of objects might take place in a school laboratory, but could also occur in an out-of-school setting, such as the student's home or in the field (e.g. when studying aspects of biology or Earth science). I also prefer not to use the term'experiment' (or 'experimental work') as a general label, as this is often used to mean the testing of a prior hypothesis. Whilst some practical work is of this form, other examples are not". (Millar, 2004, p. 2).

In conclusion, most stakeholders would accept a definition of practical work in science which includes investigation/enquiry and laboratory/field work procedures and techniques. There is some concern that too wide a

definition may reduce pupils' opportunities to engage with the physical world, but general agreement on the importance of activities which link these to the concepts, theories and context of science. A potentially significant differences is between primary and secondary teachers with respect to the role of teacher demonstration.

Inreviewing literature on the aims and purposes of practical work and why it is important in science education,the comment made by Solomon (1980) can generally capsules most teachers' first thoughts. Practical work is an important part of science but as to what value is practical work as part of science education still remains unfound. Since then, there have been many educational researchers who have produced categories of reasons for conducting practical work within science education.

Shulman and Tamir (1973), and Anderson (1976), both proposed aims of practical work. Whilst both were unique in their own right, there were common themes, such as appeal to students, improvement of scientific skills and promotion of scientific culture.

Shulman and Tamir (1973, p. 109-114) suggested five major aims of practical work in science education as follows:

(1) To arouse and maintain interest, attitude, satisfaction, open-mindedness and curiosity in science;
(2) To develop creative thinking and problem solvingability;
(3) To promote aspects of scientific thinking and the scientific method (e.g., formulating hypotheses and making assumptions);
(4) To develop conceptual understanding and intellectual ability; and

(5) To develop practical abilities (e.g. designing and executing investigations, observations, recording data, and analyzing and interpreting results).

Anderson, (1976, p.110-119) also proposed some aims of science practical work as:

(1) To foster knowledge of the human enterprise of science so as to enhance student intellectual and aesthetic understanding
(2) To foster science inquiry skills that can transfer to other spheres of problem- solving;
(3) To help the student appreciate and emulate the role of the scientist;
(4) To help in understanding the tentative nature of scientific theories and models.

Hofstein and Lunetta (1982), suggested that the purposes, as stated above, were rather similar to the purposes for science as a whole that distinct reasons for practical work were needed, especially at a time when there had been a shift from student-led work.This provided less time and experience in the science laboratory, primarily due to the need to meet examination requirements (Gott & Duggan,1995).

Hofstein and Lunetta (1982) found that when suitable activities were used in laboratories effective development and promotion of logic, inquiry and skills for problem-solving might occur. Although to what extent suchs kills and inquiry could be learnt just as effectively through other pedagogic methods and indeed in other subjects has been raised (Clackson &Wright, 1992).

According to Osborne (1998, p.156-173), unpicking the Gordian knot that ties science education to its practical base requires, first and foremost, a reconceptualization of the aims and purposes of science education. (Osborne, 1998, p. 156-173).

Wellington (1998) commented that 'teachers are always surprised and even shocked, when asked to consider what practical work in science is for. This phenomenon might simply reflect the almost sacrosanct position of 'the practical' in school science (p.143-155). Less anecdotal evidence of teachers' attitudes towards practical work comes from sources such as the ICM survey carried out on behalf of NESTA (the National Endowment for Science, Technology and the Art). ICM reported that 84% of the participants considered practical work to be 'very' important with 14% considering it 'quite' important. The high level of importance attached to practical work begs the question, why is practical work so important? The answer to that question emerges from an examination of the research into teachers' views of the aims of practical work.

In an attempt to make sense of the various aims, Wellington (1998, pp.145-146) offers a 'crude summary of arguments' for the use of practical work. 'Cognitive argument argued that practical work can improve pupils' understanding of science and promote their conceptual development by allowing them to 'visualize' the laws and theories of science. It can illustrate, verify or affirm 'theory work'. Affective arguments to practical work, also argued that is motivating and exciting – it generates interest and enthusiasm. It helps learners to remember things; it helps to 'make it stick'. Skills argument also argued that practical work develops not only manipulative or manual

dexterity skills, but also promotes higher-level transferable skills such as observation, measurement, prediction and inference. These transferable skills are said not only to be valuable to future scientists but also to possess general utility and vocational value.

However, Wellington notes several counter arguments to all these claims for practical work. Firstly, doing science and understanding science theories are different (Leach & Scott, 1995). Secondly, there is evidence that many pupils, particularly girls, are not very positive about doing experiments (Murphy & Beggs, 2003; Qualter, Strange & Swatton, 1990). Thirdly, evidence for the transferability of skills is limited (Ausubel, 1964; Lave, 1988).

Wellington (1994), also noted that the arguments for the value of practical work in promoting group work have also been criticized. It would appear that there might be some scope for the science education community to engage in consideration of the purpose of science education and, in particular, the aims and purpose of 'practical work'. Students have a lot to benefit from practical which may include increasing students' interest and abilities in science subjects as well as their achievement in science (Pavesic, 2008). In addition, Tobin (1998) and Ikeobi (2004), stated that, meaningful learning is possible from a given laboratory experiments if the students are given ample opportunities to operate equipment and materials that help them to construct their knowledge of phenomena and related scientific concepts. There are reports that emphasize teaching a science with the help of laboratory experiments to be more enjoyable and stimulating to students than teaching the

same subject matter only through lecture (Hofstein &Lunetta, 2004; Teibo, 2001).

Over the years, there have been several studies that have reported teachers' views of the aims of practical work. Kerr (1963, p. 288-350) identified 10 aims reported by teachers and a further 10 more were reported by Beatty and Woolnough (1996, p.23-30). Swain, Monk and Johnson (1999, p. 131-132,) in an unpublished study found another 10 aims. However, the four most popular aims in all three studies were:

to encourage accurate observation and description;

to make phenomena more real;

to arouse and maintain interest;

to promote a logical and reasoning method of thought.

By comparing the three studies, some trends appear, which might be explained by the influence of the National Curriculum. Four aims were rated more highly in the Swain, Monk & Johnson (1999),study than they were in the Beatty and Woolnough (1996), study.These aims were:

1. to practice seeing problems and seeking ways to solve them;
2. to develop a critical attitude
3. to develop an ability to cooperate;
4. for finding facts and arriving at new principles.

Millar (2004), argued that It is also important to distinguish, and keep in mind that, the school science curriculum in most countries has two distinct purposes. First, it aims to provide every young person with sufficient understanding of science to participate confidently and effectively in the modern world a 'scientific literacy' aim. Second, advanced societies require a

steady supply of new recruits to jobs requiring more detailed scientific knowledge and expertise; school science provides the foundations for more advanced study leading to such jobs. These two purposes may lead to different criteria for selection of curriculum content, to different emphases, and (in the particular context of this paper) to different rationales for the use of practical work.

In reviewing literature surrounding the nature and purpose of practical work, what is reflected is how there is no research specifically, into what, and why, students think and feel about practical work as well as whether practical work has an affective value in influencing students' decision to continue with science post compulsion. It appears that practical work is seen as motivating by teachers as shown through the vast amount of empirical data (Holstermann, Grube, & Bögeholz 2009). However, there is a need to ask students direct questions regarding their affection to practical work, such as" do they enjoy practical work? Does it motivate them?" (Wellington, 2005,p. 101) and probe further as to what is itthat they are indeed motivated to do and why this is so.

As Bennett and Hogarth (2009) pointed out, the plurality of espoused aims for practical work in science make the task of assessment very difficult. As is currently practiced, students claim to find practical work an 'enjoyable and effective way of learning science' (Hodson, 1992, p. 115) and this has been reported in many previous studies (Osborne & Collins, 2001; Jenkins & Pell, 2006).

Many studies (Kerr, 1963; Beatty & Woolnough, 1996; Hodson, 1990; Swain, Monk &Johnson, 2000,) have examined the aims of practical work in

science education. One common theme that emerges from these studies is the need ‘to arouse and maintain’ positive attitudes in students’ in order to improve the likelihood of their continuing to study science post compulsion.

According to Anamuah-Mensah (1989), The major aim of science practical work in secondary schools in Ghana is to bring about the technological development needed by the nation through the production of young scientists who would be able to produce and handle simple technological devices to make day-to-day life activities and to make life easier and more comfortable. Thus, practical work in secondary schools should develop essential scientific skills in the learners infusing into them creative mind to enhance their technological applications. The justification for practical work in science at the senior high school level is supported by the aims of practical science in the West African Examination Council Syllabus as follows:

1. To acquire adequate laboratory and field skills in order to carry out and evaluate experiments and projects in physics, chemistry and biology
2. To acquire necessary scientific skills, for example, observations, measuring, manipulating, classification and interpretation of scientific data
3. To be able to interpret and illustrate knowledge of physical, chemical and biological principles and to develop the ability to perform simple experiments and makes inferences from the results established.
4. To acquire scientific attitude for problem solving

5. To be able to apply scientific principles in everyday matters in order to solve personal, social, environmental, community, health and economic problems.

The importance of practical work in science is widely accepted and it is acknowledged that good quality practical work promotes the engagement and interest of students as well as developing a range of skills, science knowledge and conceptual understanding

According to Dikmenli (2009), the main purpose of practical work in science education is to provide students with conceptual and theoretical knowledge to assist them learn specific concepts and scientific methods to understand the nature of science. Thus practical work stimulates learners interest in the science subject they are studying when they are made to personally engage in useful activities; knowledge obtained through practical work and experience, promote long term memory that theory alone cannot do. From this reason, it becomes obvious that a learner acquired more in any science lesson if giving the opportunity to do activities, ranging from manipulating apparatus, classifying, designing, experimenting, hypothesizing to make inferences and verifying results

In addition, practical activities in biology provide opportunities for students to actuallymaster science and become exposed to learning about science (Nwagbo & Chukelu, 2011).

Woolnough and Allsop (1985), claimed there were three essential aims that are the principals of scientific activity, and justification for the use of practical work.These were:

(1) developing practical scientific skills and techniques;

(2) being a problem-solving scientist;

(3) getting a‘feelforphenomena.

Surprisingly, the aims they proposed did not include the motivational, stimulating and enjoyable aspects that practical work has since been claimed to promote or produce them (The House of Lords Science and Technology Committee, 2006). However, there had been comments made before this time about the use of practical work to encourage and motivate students according to teacher opinion, such as in Kerr (1963), Selmes, Ashton, Meredith and Newell, (1969), Kelly and Monger (1974).

According to Woolnough and Allsop (1985 p.195-198), it seemed that the motivation al aspect of practical work for students was far too restrictive and generally only favoured because the alternatives were presented in a negative way by teachers to students. According to Swain, Monk and Johnson (2000), this approach of using practical work as a means of behavior control has been used by teachers in the United Kingdom as a strategy for dealing with mixed achieving classes.

Due to this strategy, Swain, Monk & Johnson (2000, p 281-292), suggested three further aims as reasons for teachers doing practical work. The aims included,

(1) to reward pupils for good behavior;

(2) to allow students to work at their own pace;

(3) to add variety to classroom activities

Eventhough students may hold an interest and want to conduct practical work, it does not necessarily imply cognitive learning purely

because the context of that learning has become seemingly more relevant to the student (Adey,1997).

Indeed, just because students find doing practical work ‘enjoyable’ does not mean that students will be thinking or learning about what they are doing, rather the opportunity to have the freedom of something different in learning science. In such a case, a possible purpose to enhance scientific knowledge via practical work seems difficult to attain. This is especially true when doing science is ineffective enhancing students understanding or learning of science (Driver, Squires, Rushworth &Wood-Robinson,1994 p.110-112).

Hodson (1990, p.40) suggested five possible aims of the purpose and justification of practical work based on teachers’ responses. These are:

1. To motivate, by stimulating interest and enjoyment.
2. To teach laboratory skills.
3. To enhancethe learning of scientific knowledge.
4. To give insight into scientific method, and develop expertise in using it.
5. To develop certain ‘scientific attitudes’, such as open-mindedness, objectivity and willingness to suspend judgment.

However, after critical analysisof the above aims, Hodson (1990), found that “theoretical arguments and research evidence have reinforced the view that practical work in school science as presently organized is largely unproductive and patently unable to justify the often extravagant claims made for it”(p.39).

Indeed, Clackson and Wright (1992) drew a similar conclusion, although they suggested there might bean argument for having practical work

as a subject in its own right.The reasoning behind this was that the acquisition of skills was rather generic and thus not primarily concentrated within science education. The problem that many educational researchers had found was that due to the undefined nature of what and how best practical work should be conducted in schools, many difficulties arose with pedagogy and learning (Clackson & Wright, 1992; Hodson, 1990).

According to SCORE (2008), the problem with understanding the true purpose of practical work within science education is still an issue. This unclear focus may lead to an array of different approaches of practical work in schools that potentially will influence the learning outcomes for the students (Millar, 1998).

The Nature of Biology Practical Work

Review of literature on the nature of practical work looked at the totality and the whole embodiment of biology practical work. This include the teaching and learning environment for practical work, methods used in teaching practical work, time for teaching biology practical work and the teaching and learning resources available for teaching and learning biology practical.

There have often been agreements about the place of practical work in the learning of science education but there seems little agreement of the nature of this practical work conducted in secondary schools. Indeed, the statement made nearly thirty years ago by Solomon (1980, p.13) seemed "science teaching must take place in a laboratory; about that at least there is no controversy". Science simply belongs there as naturally as cooking belongs in a kitchen and gardening in a garden". This may encapsulate an

argument for the majority of science teachers' attitudes for why they think they do practical work. However, it still begs the question of how best this practical work could be conducted.

One important aspect in the study of the sciences and biology as such is the method used during impartation of knowledge to the students. Teaching biology through investigation, research activities, project approach and problem solving and by linking these with a focus on local environment achieves better understanding of biology as opposed to rote learning of scientific facts and theories for examinations after which learning ends. Too often in practical examinations, students show that they cannot use even rulers accurately for measurements. They claim that teaching of science in Ghana has become more theoretical than practical. There is therefore the need to search for more effective strategies that are likely to improve achievement in senior high school biology practical work. Such strategies perhaps, include co-operative based learning instructional strategies (activity-based) which have been found to improve biology learning outcomes (Okebukonla, 1984; Iroegbu, 1998; Slavin, 1990) and project base learning.

Peer tutoring is a personalized system of instruction which is leaner rather than teacher oriented, it emphasizes active student participation in the learning process. It is an individualized attention to a learner by a person of similar status who serves as the tutor. Studies have shown that this instructional strategy benefits both the students being tutored and the tutor, although the tutor is associated with greater cognitive gains than the student being taught (Annis, 1982, Bargh & Schul ,1980; Lambiotte et el; 1987). It has also been observed that when biology lessons are done in groups students are

allowed to make valuable decisions which result in satisfactory accomplishment. Mary (1996) explained that group work during practical is a pervasive and influential feature of the classroom ecosystem which must be encouraged in the teaching and learning of biology in the senior high schools.

Activity -based methods of teaching, in the form of group work during practical, enable students to be actively involved in seeking information that can be applied to solve real life problems. By these method students are placed at the center rather than the teacher and it's not text book centered. The activity method is used to teach science in which the child is placed at the center of the learning process and made to interact with materials and experience things for themselves.Practical work is an inquiry and hands on activity which makes it possible to transfer knowledge on higher order cognitive levels and create curiosity in students.

Practical work develops problem-solving skills and a deeper understanding of the concepts and principles in biology for students. When students do biology hands on, they will understand it and will enjoy the learning process since it will be relating what they will have learnt to real life situations. The challenges of the modern world require individuals who can apply their theoretical knowledge to solve practical real life problems such as environmental and economic challenges. Hence, practical work prepares students for adult life since it fosters the theory they would have learned. Students, through doing practical work, would be doing what real scientists do and they would appreciate that theories are generated from research. Doing practical work forms the basis for good research skills in students. The project approach, therefore, enhances the development of many practical work skills.

Katz and Chard, (1989 p.5-7), correctly stated that “The Project Approach, involves children selecting a topic of interest, researching and studying it, and solving problems and dilemmas as they arise.” The Buck Institute of Education describes it as, “Project Based Learning (PBL), where students go through an extended process of inquiry in response to a complex question, problem, or challenge”. The extended interactions with learning materials enable students to learn new material and transfer understanding to other new situations. The importance of time spent with learning material is emphasized further by Bigala (1996, p.74), who defines project work “as a scheme of work in which the pupils work singly or in groups, over a period of time varying from a few days to several weeks”. Khan and Zafar (2011), carried out an experiment in which they sought to compare the effectiveness of the traditional laboratory and the inquiry (project) methods in developing scientific process skills in grade nine pupils using selected topics in the biology syllabus. They determined that, using a science process skill scale device, pupils taught using the inquiry method developed better science process skills than those taught the traditional way. In addition, Shoemaker (1989), explains how science is best taught in a holistic way which reflects the instructiveness of the real world. This complements Benson (2004), argues that the implication is, therefore, that teaching strategies should be based on the premise that learning is a series of connections and goes on to suggest that the project method and theme teaching fit this description. Abimbola (1994), makes the case that in Nigeria; teachers usually give the excuse of lack of materials and equipment for not carrying out practical work even when an activity can be done without conventional equipment. Abimbola’s article cites

that while there are essential laboratory skills like manipulation of various forms of equipment, equally important inquiry skills can be developed through methods like projects done outside the laboratory. Bigala (1996), found it feasible to use the project approach in schools in Malawi and goes on to give examples of such projects in different subjects including biology. Bigala (1996), also suggested ways of structuring the projects, organizing, and timetabling them.

The activity-based method of teaching considers students as very important in the instructional process, where teachers build on the students' experiences. Also, the procedure used for the activity-based method of teaching is based on current information and research in developmental psychology involving cognitive, affective, experimental and maturational issues.

Co-operative work on problems and issues is a common phenomenon associated with the activity -based methods of teaching science. Also, individualized and personalized instructional strategies, recognizing student's diversity are employed. The curriculum structure for the activity -based method of instruction is multifaceted, including local and community relevance as well as considering values ethical and moral dimension of problems and issues, using the natural environment and community resources. Some of the approaches used for the activities include group activity, project work, practical work, inquiry, discovery, discussion and demonstration. In all the approaches mentioned, practical work is found to permeate in all aspects and they in turn relate to one another. In science practical work, it is necessary for students to offer each other assistance.

According to Lazarowitz, Lazarowitz-Heads, and Bird, (1994), learning methods generally involve heterogeneous groups working together on tasks that are deliberately structured to provide specific assignments and individual contributions for each group members. Practical work is found to enhance the teaching and learning of science and for that matter biology at all levels. Co–operative learning within groups will enable students to have cognitive as well as social benefits as they clarify their own understanding and share their insights and ideas with each other as they interact within the group during biology practical activities (Lazarowitz, Lazarowitz-Heads & Bird 1994). They further found that emphasizing laboratory inquiry had a small equity effect, while emphasis on critical thinking was associated with a magnification of gender and minority gaps. They concluded that de-emphasizing traditional, teacher–centered instruction is expected to increase average science achievement and minimize gaps in achievement between individuals of different socio- economic statuses.

Kolb (1994), recommended that teachers help students to become critical scientific thinkers by teaching life science through inquiry. Through scientific inquiring, students learn the intricacies of investigations, including experimental design, data collection, data interpretation and explanation and defense of results. Advantages of using the Activity–Based Method in teaching biology practically includes:

1. Students are trained to easily identify problems with local interest and impact.
2. Students are also encouraged to use local resources in locating information that can be used in problem resolution.

3. It also extends the learning situation beyond the classroom.
4. Teaching and learning become more realistic and meaningful to students who explore and share ideas together.
5. High order thinking skills in the context of the problem, rather than seeing problems as separated entities in the school program is enhanced.
6. Creativity, freedom of expression, initiative and leadership qualities are inculcated into students.

Though the activity-based method is perceived to be one which help students to explore, there are some disadvantages. They include the following:

1. Lesson may take a very long time for students to go through the activity successfully.
2. Students normally become frustrated especially, when they fail to discover or find the solution to a problem.
3. Organizing, managing and controlling of students towards effective achievements of results can be difficult.
4. It can be an expensive method of teaching considering resources, materials and funds to be provided for the learning process.

In spite of the disadvantages of the activity-based method of teaching it enable students have more hands on than minds-on experiences in the teaching and learning of science.

The lecture Method is also used in the teaching of biology practical lessons. This method includes the lecture and the programmed instruction. Instructional procedure is a one-way process where the teacher transfers a body of knowledge to students according to a pre-planned scheme. The lesson is teacher- centered and the students are regarded as recipients of instruction.

The teacher therefore ignores students in terms of what they might bring to the classroom.The lecture method is also regarded as textbook controlled, which is an inflexible with minimal consideration given to the students' abilities. The teacher only presents his ideas, develops them, evaluate and summarize the main points for the students to listen and prepare their own notes.

Advantages of the lecture method as a medium of instruction include

1. More topics are covered in a relatively short period of time.
2. Students are given good training and insight into the techniques of analyzing issues.
3. The method is very suitable for teaching very large classes
4. It is very easy in using to deliver knowledge.

With the advantages stated above this method has numerous disadvantages which makes it unsuitable to use in practical lessons. Disadvantages of the lecture method include

1. Lessons, which are not interesting and also very long, may bring about boredom in the teaching process.
2. Class involvement, class participation and process skill development are not encouraged.
3. The method cannot be effective, in teaching some specific concepts and subjects at the senior high school level.
4. Students understanding is rarely-assessed during lectures, because students are not encouraged to participate fully in the lesson.
5. It leads more to rote learning and does not give actual understanding of science concepts.

The debate regarding the nature of practical work (the method of practical work that would suit the learning of science best both effective and affectively) has taken avariety of formsthroughouthistory including "the discovery approach, the process approach and 'practical work by order'(Wellington, 2002, p. 56).

The discovery approach to practical work was criticized for providing a seemingly false view of science (Kirschner,1992), the idea of reaching theoretical conclusions solely from observations, known as the "inductive process" (Wellington, 2002, p.56). This style is similar to the heuristic approach, become overly focused on the physical application of doing practical work. Instead of understanding scientific concepts it made doing science appear as a method, a set of rules, that could be applied to determine any scientific theory. As Jenkins (1979) explained:

> "As the concepts and imagery of science were seen to be removed further and further from 'common sense',it became increasingly difficult to argue convincingly that pupils must be put in the position of an original discoverer and to maintain that science owed its achievements to a method which was merely 'a game' whose rules could be learnt and applied".(p. 50)

Moreover, there were problems for teachers in applying the approach in science lessons. More often than not, students were unable to observe the desired (or expected) phenomenon. Such problems may have been due to the "fallacies in the assumptions underlying the approach" (Millar,1989, p. 50) rather than the teacher's capability amongst other reasons. To whatever extent the criticisms are placed, there are still a number of experiments with new items of apparatus which have become customary in today's science lessons (Wellington, 2002). Although some recipe method experiments have

become iconic of current teaching, there is little acknowledgement that, doing leads to students' understanding or that engagement in science increased with such an approach (Millar, 2004;Woodley, 2009).

The process approach, to some extent, had more extensive criticism than the discovery approach (Wellington, 2002; Millar, 1991). The model involved the notion that science could be as set method of discrete processes whereby skills and processes could be separate from the natural theoretical aspects of science (Millar,1991). The approach was trying to provide a science for all abilities. There was the view that if students were less able, learning scientific transferable skills would be more appropriately suited to them, over any scientific content (Wellington, 2002). Such an approach to scientific practical work seemed to provide an unbalanced view of what it meant to study science.

Millar and Driver (1987), explained how "the aims should be the development of a deeper understanding of the concepts and purposes of science. For science, we would argue, is characterized by its concepts and purposes, not by its methods" (p. 56). Furthermore, Gott and Mashiter (1994), noted that "while acknowledging that the methods of science are important, the methods are those of induction and operate within a concept acquisition framework" (p.182). Furthmore, they continue to suggest that this is a possible reason for the possible limitation of practical work in influencing students' attitudes in studying science. According to Chalmers (2006), the modelof science that is constructed within a process approach, such as the Warwick Process Science in 1967, is based on a naïve intuitivism that many view as unsound (such as Leach, Millar, Ryder & Séré, 2000). Moreover, the

process approach was teaching skills learnt naturally from a nearly age (Hodson & Bencze, 1998; Millar, 1989; Wellington, 1989), such as observing that a plant grows if it is provided with the right amount of nutrients or the classification of objects according to certain properties.

The final approach that Wellington (2002), referred to regarding practical work by order, relates to the more recent situation since the National Curriculum was introduced in 1988. In 1988 the Department for Education and Science stated five components with practical work being included in the form of investigations. Eventhough the National Curriculum was adapted in 1992, 1995, and 1999, practical work was, and still is, a major part, constituting Attainment Target 1 or later Sc1 scientific enquiry (Jones & Roberts, 2005). From the 1992 version of the National Curriculum, the problem was regarding discrepancies in the assessment of practical work (Daugherty, 1995). If students were being assessed on their scientific facts, then the question arose regarding what the students were actually investigating and what was being examined. These problems have continually been faced by teachers and have led to criticisms such as those made by Donnellyet al. (1996):

> What did it test: the scientific idea or the pupil's experimental procedures? If, as mustsurely be the case, the latter, then why makes the linkage to the former at all? And if, as again seems likely to have been the case, the established scientific outcome was clear, in what sense was the investigation open? (p. 47)

The nature of the practical work since 1988 has provided one specific model which has been noticed as being flawed bys ome (Kelly, 1990; Wellington, 2002). Furthermore, the different approaches current teachers use to conduct practical work can have an influence on the learning outcomes.

The approaches can be either inductive or deductive in nature with explicitor implicit instructions given by the teacher on conducting the practical work (Hodson, 1990). The National Curriculum for Science has often been remarked as being burdened by too many facts and concepts primarily required for examinations (Gummer & Champagne, 2006). Indeed, SCORE (2008), explained how teachers found the science curriculum content as the major barrier for limiting the amount of practical work conducted. Furthermore, it has been observed that for somes tudents this focus on content has led them to be disengaged with learning about science (House of Commons, 2002a; Kind & Taber, 2005).

From a historical perspective, there have only been three major studies into the nature and purpose of practical work in England and Wales: Kerr in 1963 and Thompson in 1975. Eventhough their questionnaire-based studies are specificin terms of both cases and times in history, they are continually referred to and analyzed. The studies are primarily used in the debate regarding the nature, aims and purposes of practical work.

The missing link between learning biology to pass an examination and learning biology to select a career can be attributed to the need for innovativeness, improvisation and foresight by teachers to consciously expose the students to biology in action through the use of modern teaching aids, application of videos, education tours etc. There is the need by the biology teacher to demystify the teaching and learning of biology and science as a whole and to make the process more interesting and to promote the inquisitiveness of the students

Three areas to be addressed to demystify the teaching and learning of biology and all the sciences and also make the process more interesting are

1. introducing new ideas, knowledge and educational technologies (including audio-visuals aids)
2. improving the teaching and learning environment
3. embarking on outreach program.

Available Resources for Biology Practical Work

The availability of teaching and learning materials for biology practical work plays an important role in the learning of biology. In his study, Bajah (1984) found a significant relationship between teachers, facilities and schools' academic performance. Adequate provision of instructional materials is an important method that science teachers can use in promoting skills acquisition in consonance with the objective of developing manipulative skills in students (Eshiet, 1987).

Ogunyemi (1990), found out that when physical and material resources are provided to meet the needs of a school system, students will not only have access to reference materials maintained by the teacher but individual students will also learn at their own pace. The net effect is that it increases the overall academic performance of the students. In his own contribution, Gamoran (1992), noted that school resources and books in the library alone, had little impact on students' achievement once student background variables are taken into account. This meant that before such students could perform well at the higher educational level, they must be supplied with the requisite educational materials at the secondary level to propel them to higher achievement.

Many scholars (Bajah, 1984; Akinwumigu& Orimoloye, 1986) were of the view that availability of physical and material resources are very important for the success of any worth while educational endeavour. These researchers agreed that, availability of adequate school buildings, number of classrooms, chairs, desks and laboratories for science teaching are imperative for the attainment of any educational objectives. Hallak (1977), identified facilities as a major factor contributing to academic achievement in the school system. According to him, the facilities include the school buildings, classroom accommodation, furniture, libraries, laboratories, equipment and other instructional materials.

Arubayi (1987), found a positive relationship existing between the independent variables of laboratory facilities, recommended text books, number of science books in the library and teachers' qualifications and the dependent variable, academic performance of students in biology, chemistry and physics. Obemeata (1995), provided evidence to support the claim that physical structure is significantly related to school academic performance. Effort must therefore be made to renovate the dilapidated science laboratories and schools offering science without separate laboratories for science must be assisted to construct more laboratories. careful note must be given to the available biology teaching and learning materials. Special attention must be paid to these materials used during lessons to maximize the students' learning.

The Role of Practical Work in the Teaching and Learning of Biology

Practical work is an inquiry and hands on activity which makes it possible to transfer knowledge on higher order cognitive levels and create curiosity in students. The claim that teaching of science in Ghana has become

more theoretical than practical. There is therefore the need to search for more effective strategies that are likely to improve achievement in senior high school biology. Such strategies perhaps, include co-operative based learning instructional strategies (activity-based) which have been found to improve biology learning outcomes (Okebunkola, 1984; Iroegbu, 1998; Slavin, 1990).

Practical work develops problem-solving skills and a deeper understanding of the concepts and principles in Biology for students. When students do biology, hands on, they will understand it and will enjoy the learning process since it will be relating what they will have learnt to real life situations. Teaching biology through investigation, research activities and problem solving (practically) and by linking these with a focus on local environment achieves better understanding of biology as opposed to rote learning of scientific facts and theories for examinations after which learning ends. Too often in practical examinations, students show that they cannot use even rulers accurately for measurements.

The challenges of the modern world require individuals who can apply their theoretical knowledge to solve practical real life problems such as environmental and economic challenges. Hence, practical work prepares students for adult life since it fosters the theory they will have learnt. Students, through doing practical work, would be doing what real scientists do and they would appreciate that theories are generated from research. Doing practical work forms the basis for good research skills in students.

The project approach, therefore, enhances the development of many practical work skills. Katz and Chard (1989), correctly stated that “The Project Approach, involves children selecting a topic of interest, researching and

studying it, and solving problems and dilemmas as they arise." The Buck Institute of Education described it as, "Project Based Learning (PBL), where students go through an extended process of inquiry in response to a complex question, problem, or challenge". The extended interactions with learning materials enable students to learn new material and transfer understanding to other new situations.

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It has also been observed that when biology lessons are done in groups, students are allowed to make valuable decisions which result in satisfactory accomplishment. Mary(1996), explained that group work during practical is a pervasive and influential feature of the classroom ecosystem which must be encouraged in the teaching and learning of biology in the senior high schools. Activity -based methods of teaching practical in the form of group work during practical, enable students to be actively involved in seeking information that can be applied to solve real life problems. By this method, students are

placed at the center rather than the teacher and it's not text book centered. The activity method is used to teach science in which the child is placed at the center of the learning process and made to interact with materials and experience things for themselves.

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Abimbola (1994), makes the case that in Nigeria; teachers usually give the excuse of lack of materials and equipment for not carrying out practical work even when an activity can be done without conventional equipment. Abimbola's article cites that while there are essential laboratory skills like manipulation of various forms of equipment, equally important inquiry skills can be developed through methods like projects done outside the laboratory.

Performance of students in Biology and Biology Practical in Secondary Schools

The teaching of biology as a subject in secondary schools is faced with many problems. The poor academic performance of students in biology as indicated in the report of WAEC Chief Examiners' report has become a persisted public outcry as regards the falling standard of biology education. This is mostly in the area of unavailability of laboratories and other teaching facilities in their right number of students studying science. Biology is a very important subject; it has to be given more priority. It enables one to

understand himself and his intermediate environment. Nevertheless, the knowledge acquired in biology subject is applied in many fields as Medicine, Biochemistry, Pharmacy, Microbiology and Agriculture among others. Students' performance in Biology subject in Senior Secondary Certificates Examination (SSCE) has been unsatisfactory over many years. Various reasons have been attached to this problem by scholars.

Dinah(2013) concluded that, availability of text books, laboratory apparatus and other learning resources contribute significantly to the performance of students in biology examination. She added that, students with positive attitude towards the subject register better performance than those who had a negative attitude. Those with positive attitude are motivated to work hard and this is reflected in the good marks scored in the examination.

Suman(2011), conducted a research on influence of parents' education and parental occupation on academic achievement of students. He concluded that education and occupation of parents positively influence the academic achievement of children in biology.

Femi (2012), concluded that education qualification of parents and health status of students are significant factors that affected the academic performance of biology students in senior high schools. Femi(2012), in his study stated that, socio-economic and education background of parents were not significant factors in students' performance.

According to Akinsanyo, Ajayi and Salomi (2014), parents' education has the highest significant influence on the academic achievement of students. This is because the child from educated family has a lot of opportunities to

study hard due to his/her access to internet, newspaper, television. They can also be taught extra lessons at home. Students raised from an illiterate family have limited access to that. It has been observed that the falling academic standard and the influencing factors include the economic status of the parents. Just having a look at the present economic situation of the country, many poor parents do send their children to go and do pity house hold work before going to school. These children were confused on what they can help their family through that. However, poverty of parents has elastic effects on their children academic works as they lack enough resources and funds to sponsor their education and good school, good housing facilities, medical care and social welfare services.

Osuafor and Okonkwo (2013), in their research on influence of family background on academic achievement of secondary school biology students found that family structure, parents' occupation and educational level of parents did not have significant influence on students' achievement in biology. Memon, Muhammed & Muhammed (2010), in their study revealed that majority of students whose parents were well educated perform better in matriculation examination as compared to those students whose parents were less educated or illiterate.

Mamalanga and Awelani (2014), noted that the possible factors responsible for the poor performance in biology included lack of financial support, lack of equipped libraries, lack of laboratories and biology textbooks, method of teaching and accessing biology. Furthermore, practical biology examination if highly scored improves students grade in biology.Teachers should be encouraged to asses' learners regularly on practical skills. Perhaps,

more practical lessons should be availed and documented so that teachers would plan for them and regular inspection to insure the actual order is adhered to (Wabuke & Mukhwan, 2013).

Cohen, Manion and Morrison (2007), put it that "directly or indirectly classroom interactions are controlled by the teacher for it is he who promotes particular learning situation through his choice of objective, organization of experience, selection of materials and methods in order to facilitates the students' academic performance. Owino, Ahumad and Alice (2014), linked the problem with inadequate supply of teaching and learning resources such as chemicals, charts, apparatus, models, local specimens, laboratories, textbooks, and libraries led to poor performance in biology. They added that irregularities related to the teacher of Biology such as irregularity in administration of practical, class discussion, teachers not allowing students to ask questions, teachers not giving prompt feedback on assignments or exams, by not making the Biology subject interesting and teachers not conducting demonstration during practical.Nwosu (1998), reported that most teachers lacked the knowledge of curriculum objectives as indicated by their failure to implement them.

The above mentioned studies indicate the possible factors responsible for low academic performance of students. In order to improve student's achievement and arouse their interest, students have to be taught biology with hands on and different learning materials so as to enable them acquire the cognitive competence and professionals of biology that they need in passing biology.

Effect of Practical Work on the Performance of Students in Biology.

According to Longman Dictionary of Contemporary English (2005), "Effect" means (i) a change produced by an action or cause; a result or an outcome; (ii) an impression created in the mind of a spectator, read, etc while watching a play, listening to music or looking at a painting. Effect as used in the research can then be defined as a positive change produced by an action, a desirable outcome or a result.

Onah (1994), emphasized that teaching involves more than talking all time. Resources such as diagrams, fields work and real objects when effectively used to explain the subject matter very well than a lecture. The proper place for effective practical activities is the laboratory. Biology being one of the science subject cannot be taught or learnt effectively in the absence of practical activities Iloeje (2007), in his lesson for effective biology practical activities stated that, of all the five sense of organs used, the sense of sight is the highest of them.

CHAPTER THREE

RESEARCH METHODS

Overview

This chapter contains the research approach and design, research instruments, population size and the study sample. Also presented are the validity and reliability of the instruments, data collection procedures as well as the data analysis method utilized.

Research Design

The mixed methods approach was used in this study. The mixed methods approach is a methodology for conducting research that involves collecting, analyzing and integrating qualitative (e.g. Experiments, surveys) and qualitative (e.g. focus groups, interviews) research. (Creswell, 2003). This approach uses the strength of both methods to provide a broader perspective about the issue under investigation. Mixed methods approach to research is used when a researcher needs to converge or validate results from different methods. The approach can also be used when the researcher wants to elaborate, enhance or further clarify the results of a method. Mixed methods approach is also used when a researcher wants to expand the breadth, depth and range of the research by using different methods and different ways of inquiring resulting in more comprehensive results. This helps to expand the scope of the study.The advantages with this method is that it is easy to describe and report. Also it provides strengths that offset the weaknesses of both qualitative and quantitative. It provides a more complete and comprehensive understanding of the research problem than either quantitative or qualitative.However, its short coming has to do with the fact that it may be

unclear how to resolve discrepancies that arise in the interpretation of findings.it also takes much time and resources to plan and implement this type of research.Different types of the mixed methods design have been identified. They include: sequential explanatory design, sequential exploratory design, sequential transformative design, concurrent triangulation design, concurrent nested design and concurrent transformative design.

This study employed the sequential explanatory design to explain and offer insights into the performance of senior high school students in biology practical work. Sequential explanatory design involves the collection and analysis of quantitative data followed by the collection and analysis of qualitative data. This method is a two phase design where the quantitative data is collected first followed by the qualitative data. The purpose is to use the qualitative results to further explain and interpret the findings from the quantitative phase. In this case, the priority is given to the quantitative data and the findings are integrated during the interpretation phase of the study. The strength of a sequential explanatory design is that it is easy to implement because the steps fall into clear separate stages. Also the design is easy to describe and the results easy to report. Although, sequential explanatory design has several advantages or strengths, they also have few limitations. It requires a substantial length of time to complete all data collection given in the two separate phases.

Population of the Study

The population of the study consisted of all the 130 SHS 2 elective biology students in three selected senior high schools within the Ledzokuku municipality in the Greater Accra region of Ghana. The population was made

up of 43 students from school A (30males and 13 females),46 students from school B (27 males and 19 females) and 41 students from school C (29males and 12 female).

The elements of this population are finite and different in terms of age, sex, race and ability in performance.

Sample of the Study

The sample of the study consisted of 90 students selected from the threeselected senior high schools in the Ledzokuku municipality.The sample consisted of 17 males and 13 females from school A, 15males and 15 females from school B and 20 males and 10 females from school C. In all, the sample consisted of 52 males and 38 females.30 students were selected from each school as the sample because the classrooms in the sampled schools were able to contained a maximum of 30 students for effective examination.

Sampling Procedures

The list of all senior high schools in the Ledzokuku municipality were obtained from the Regional Education Directorate in the Greater Accra Region of Ghana. Out of the total number of five senior high schools within the municipality, the researcher used the purposive sampling technique to select three schools for the study. According to Van Dalen(1979), a sample should contain at least 10% to 15% percent of the population.In agreement with this three (60 %) out of the fivesenior high schools within the municipality were selected using the purposive sampling technique. The purposive sampling technique was used because some of the schools in the municipality do not offer science as a program. Alsoothers were private

schools and did not allowed the research to be conducted in their schools.The sampled schools were coded A, B and C for easy identification and handling.

The sample was selected using the stratified random sampling technique. In each school, students were grouped into two strata namely males and females. Simple balloting was then used to select the proportion of males and females to form the sample of the study. Students who picked papers with serial numbers in each group formed the sample of the study and the serial numbers remained their numbers throughout the test. The researcher used stratified random sampling because it increases precision and representativeness of the study sample.

Research Instrument

I made use of Performance Assessment Test and Semi-structured interview as instruments for data collection. The instrument for the performance test was known as Biology Practical Performance Test (BPPT). Four different Biology Practical Performance Test (BPPT) were developed by me based on the SHS elective biology teaching syllabus taking into consideration the various tasks along which students are tested during the WASSCE biology practical paper (biology paper 3). The tasks considered in this study were Observation task (observable features), Adaptation task (adaptive features), Drawing task, Habitat task and Classification task.

Each Biology Practical Performance Test (BPPT 1, BPPT 2, BPPT 3 and BPPT 4) consisted of a maximum of 5 open-ended items with each item testing students' performance in one task. The items used in the test were drawn from past questions of WASSCE biology practical papers.

Each test covered specific topics from the SHS elective biology syllabus. Test one covered the topic “Life Process of Living Things (2)”.Test two (2)covered the topic “Plant Structure and Physiology” and test three (3) also covered the topic “Life Processes of Living Things (1)”. Test four (4) covered a combination of topics: “Anatomy and physiology of mammals and Formation of Seeds and Fruits”. However, the topic “Diversity of Living Things (2) was common to all tests.

These topics were considered because they are the major topics in which students are mostly examined during the WASSCE biology practical paper (Biology paper 3).

Specimens were provided from the topics for students to use in performing the tasks assigned to them by the items on the Biology Practical Performance Test (BPPT) during the test. This was done to make the test have the same format as the WASSCE biology practical paper (biology paper 3). Each test lasted for 30minutes and was scored over a total of 20marks. A student score 4marks for successful completion of one task.

Validity of Instrument

In order to ensure the content and facial validity of the items, the Biology Practical Performance Tests (BPPT) were given to a senior biology teacher and supervisors to vet the items. The items were vetted in terms of their relevance to the subject matter, coverage of content area, appropriateness of language usage and clarity of purpose.

Pilot Testing

The test instruments: Biology Practical Performance Tests (BPPT) that were used to collect data for the study were pilot tested on representative

sample in a selected school in the Tema metropolis in the Greater Accra region which was not part of the study to obtain a normative data. The result of the pilot testing was subjected to SPSS analysis to obtain the reliability coefficient value. The pilot study enabled me to restructure the items on the performance tests in order to help elicit correct responses.

Reliability of Instrument

After the pilot test, a reliability co-efficient of the instrument (Biology Practical Performance Test) was determined using the Cronbach alpha. The Cronbach alpha value for the Biology Practical Performance Test was 0.72. The Cohen's Kappa value was then used to calculate the coefficient of reliability of the marking schemes. This was then compared with the tabulated coefficient of reliability which is acceptable at 0.7. The reliability co-efficient for the marking schemes for the Biology Practical performance test was found to be 0.82. The marking schemes were accepted as a reliable instrument because K was found to be greater than 0.70 which is accepted as the satisfactory value.

Data Collection Procedure

Data was collected using the Biology Practical Performance Test (BPPT) and semi-structured interview schedules. I administered the Biology Practical Performance Test myself in the sampled schools.Before the data collection began, I used one week to visit each of the sampled schools to meet the teachers and students. The visits were meant to enabled me established rapport with all the respondents. An additional purpose of the familiarizations visits to the schools was to enabledme explain the purpose of the study to the

respondents and to elicit their maximum co-operation so that the objective of the study could be achieved.

The researcher used one week to collect data from the sampled schools. One test was written by students each day in all the sampled schools.Data was collected based on what students had been taught in their biology practical lessons. I did not apply any treatment to the respondents before the data collection.

In each test, students were provided with five different specimens taken from selected topics in the senior high school elective biology syllabus and were asked to carry out five different tasks using the specimens provided. The five tasks assigned to students in the biology practical performance test (BPPT) were:

1. Classification task: Students were asked to group or classify specimens into their respective taxa according to their common features or characteristics.
2. Observation task: Students were asked to observe the provided specimens carefully and come out with their external or observable features such as colour, form, texture and structure.
3. Drawing task: Students were asked to observe the specimen and clearly draw and label the various parts.
4. Adaptation task: Students were asked to relate the structure of some specimens to their function and how they enable them to survive in their environment.
5. Habitat task: Students were asked to provide the correct habitat for the specimens provided.

After arranging the specimens neatly on tables in the classrooms for schools without laboratory and in the laboratory for schools with laboratory, students came in to start the test. After 30 minutes, the papers were collected and marked by the researcher. The same thing was done for all the four days in all the three sampled schools. Students were interviewed after each test based on their scores to probe further into their performance in each of the test.

Data Analysis Procedures

Data collected from respondents was analyzed using the Statistical Package for the Social sciences (SPSS version 21) software. The responses to each item in relation to the research questions were presented in frequency tables and then analyzed with respect to the total number of respondents from all the sampled schools. Research question one was analyzed using descriptive statistics such as means and standard deviation. Also a grading system wasadopted from the Ministry of Education Teaching Syllabus for elective biology andused to determine the overall performance of students in all the task. The grading system used in this study was:

Score	**Grade**	**Interpretation**
80------- 100	A1	Excellent
75 --------79	B2	Very good
70 --------74	B3	Good
65 ---------69	C4	Credit
60 ---------64	C5	Credit
50 ----------59	C6	Credit
45 ----------49	D7	Pass
44 -----------40	E8	Weak pass
39 ---- ------ 0	F9	Fail

Based on the scores and the grades obtained, students' performance was described under three main levels namely "Above average" (70-100)","Average" (69-50) and "Below average" (0-49). Research question two was also analyzed using Analysis of Variance (ANOVA) to compare students' performance in the various tasks assigned in the tests. Research question three was also analyzed using the independent sample t-test to compare the performance of males and females in the various tasks assigned to students in the tests.

However, results from interviews were transcribed and further analyzed for easy interpretation and understanding.

CHAPTER FOUR

RESULTS AND DISCUSSION

Overview

This chapter presents and discusses the response to the data collected in relation to the performance of senior high school biology students in practical work. The study aimed at investigating the level of performance of senior high school biology students in practical work. Results discussed in this section were obtained from a sample of 90 elective biology students selected from three senior high schools within the Ledzokuku Municipality of the Greater Accra Region of Ghana. The study was guided by three research questions and two research hypothesis.

Data Presentation by Research Question

The results of data collected have been presented research question by research question.

Research Question One

What is the performance of senior high school studentsin biology practical work?

Research question one was meant to investigate the performance of senior high school students' in biology practical work. In doing this, students were given four different tests within a week. In each test, students were provided with 5 different specimens taken from the major practical topics in the senior high school elective biology syllabus and were asked to answer questions on them.

The mean scores of students in the four different tests are shown in Table 1

Table 1-*Distribution of Mean Scores of SHS Biology Students in Biology Practical test*

Test	Number of items	Mean scores (%)	Std. deviation
Test 1	5	62.17	17.207
Test 2	5	37.78	17.644
Test 3	5	51.06	15.588
Test 4	5	33.61	13.492

Number of respondent (N) = 90

The results in Table 1 show that the students' highest mean score was 62.17% and that was in Test 1 and the mean score of students' in Test 4 was the lowest and that was 33.61%. Considering the number of items and their respective means, it shows that students performed averagely in Test 1 and 3 and below average in Test 2 and 4.

The average performance of students in Test 1 might be due to the fact that the specimens used in Test 1 were taken from a more familiar topic of the biology syllabus. The specimens used were specimen:

A ---------- Domestic fowl D ---------- Agama Lizard

B ----------Rabbit E ---------- Young Toad

C ---------- Bony fish/Tilapia

Test 1 assessed students' knowledge and understanding on the topic "Life Processes of Living Things (2). Life Processes of Living Things (2) examines students understanding in the life processes and external features of some vertebrates. It also enlightens students' understanding on how the external features of these vertebrates are related to their functions and how they are adapted to their various habitats. Students average mean score

(62.17%) in this topic shows that students have fair idea of the content in this topic since it deals with organisms mostly found in their environment and as such students are familiar with these specimens and were able to identify them, so they were able to perform most of the tasks using the specimen provided. The average performance also indicates that students were having some difficulties in performing some of the tasks that were assigned

However, the specimens involved in the teaching and learning of this topic are not difficult to obtain so teaching and learning materials are always available for teaching the topic. Students are able to interact with life specimens even in their classrooms during normal lessons and this has helped to enhance students' understanding of the topic hence leading to the average performance of students in the test. This finding is in line with Millar (2004), who argued that biology practical work was not only confined to the laboratory but taking students round to observe and interact with plants and animals within their immediate environment also serves as practical work. According to Owino, Ahumad and Alice (2014), inability of a school to provide adequate teaching and learning resources such as chemicals, charts, apparatus, models, local specimens, laboratories leads to poor performance of students in biology.

Some responses given by students during the interview section as to why they performed better in Test 1 than all the other tests include:

> Michael in school A: "I pass Test 1 because all the organisms provided as specimen in the questions I have been taught; their habitat, classification, everything there was something that I understand."

> Edna in school C: “Test 1 was not difficult because the specimens were familiar specimens and we have even observe some with our teacher”
>
> Monica in school B: said “Test 1 was not difficult because all the specimen provided were familiar and even if you have not been taught, you can observe the specimen and use your own ideals to answer some of the questions since you know the names of the specimen.”
>
> Eric in school C also said: “Test 1 was straight forward and simple because the specimens were specimens that after seeing them you can provide some of the answers to the questions”
>
> Nii in school A: also commented that “I did well because the specimens were specimens that we have been taught in the class.”
>
> Frank in school B: also said “oo I did well because the test was not that difficult; apart from some few words that the spelling was confusing, the rest of the answers were straight forward.”

The results from the interview sessions showed that students’ interest in a topic is an important factor in enhancing students’ understanding in that topic and hence improving their performance in the subject as a whole. This implies that teachers must employ methods that stimulate and arouse students’ interest in the various topics that they are teaching in order to enhance students’ understanding in the topic. This finding is supported by Hodson (1990), who stated that one of the majoraimsandjustificationofpractical work in secondary school science was to motivatebystimulatinginterest and enjoyment of students during the lesson. The Ministry of Education teaching syllabus for elective biology (2010), advocated the teaching of every topic in biology practically since this method has been found to arouse students’ interest in the study of biology as a subject (Ministry of education,2010). According to Serwaa (2007), most teachers despite the role that practical work

played in arousing the interest of students during learning, neglected its uses in their teaching due to factors such as time constraints, lack of laboratories, overloaded curriculum, large class sizes and inadequate resources.

The results from the interview also showed that students perform better in biology practical when they are familiar with specimens provided and can be found in their environment. Also students perform well in practical work when students have been taught the topic from which the specimens provided for the practical work were taken from. Also when students are familiar with specimens provided, their performance improve.

The students' mean score in Test 2 was 37.78%. This showed that students performed below average in this test. This performance of students in Test 2 might be due to the fact that students were not well acquainted with the topic from which the specimens used for the test were taken from. Also most students at that time might have not been taught that topic. The specimens used in Test 2 were taken from the topic: "Plant structure and Physiology". The specimens provided were:

A ---------- Twig of mango D ----------*Euphorbia* plant

B ---------- Twig of *Ixora* E ---------- *Crotalaria* flower

C---------- Water Lettuce

The students were not familiar with these specimens so most of them were not able to identify the specimens provided. Due to this, they could not answer the questions. For example, a student might have knowledge of the plant *Ixora* or *Euphorbia* but might have not seen it before and hence was not able to identify the plant and used the knowledge he/she has to perform the tasks assigned to him/her. "Plant structure and physiology" examines

students' knowledge and understanding in their ability to describe the external features of monocotyledonous and dicotyledonous plants, their ability to relate plants' external and internal structures to their functions and the ability of plants to perform all the various life processes and how these plants are adapted in their habitat. This topic is at the latter part of the syllabus and as such most teachers are not able to teach it due to time constraint and the overloaded curriculum. This finding is in line with a study conducted by Obidiwe (1992), who identified the overloaded curriculum as one of the major factors contributing to students' poor performance in biology practical work.Science Community Representing Education (2008), also explainedhow teachers foundthe overloaded science curriculum asthemajorbarrierforlimiting theamountofpracticalworkconducted in their schools. This also confirmed the Chief Examiners' BiologyReport (2014), which stated that students do not perform well in the biology practical examination when most of the specimen provided are plants. According to the report, questions on plants whether in theory or practical examinations pose problem to students. Most students avoid questions on plants and the few ones who attempt them are not able to answer the questions well. This shows that students lack in-depth knowledge in plant structure and physiology as an aspect of biology.

The results of the interview revealed that students were not taught the topic as at the time that the test was taking place so they did not have enough knowledge that will help them perform the tasks. Most students also said that they lack interest in studying about plants since they seem difficult to them. This negative attitude of students towards the learning of plants structure and physiology and other plants related topics accounted for their below

averageperformance inthe test involving questions on plant structure and physiology.

Students responses to why they performed below average in Test 2 include:

> Bismark in school A: “we have not been taught anything about plants being theory or practical.”
>
> Isaac in school C: “I don’t like plants questions at all. Most of the specimen are not familiar and sometimes you don’t even know what to write “
> Belinda in school C; “We have not been taught but I like animal specimens than plant specimens. I don’t know a lot of plants so I always find it difficult answering questions on plants”
>
> David in school B: “plants specimens are not easy to identify koraaaaaa. I did not know the plants names so I could not classify them.”

This shows that students’ performance in biology practical test is below average when students are not familiar with the specimens provided and when they have not been taught the topic from which the specimens provided were taken from. This also shows that senior high school biology students in the Ledzokuku Municipality lack in-depth knowledge in the topic: plant structure and physiology and other plant related topics.

The mean score of student’ in Test three was 51.06%. This shows average performance of students in test three. The average performance of students in test three shows that students did not have high mastery of the topic from which the specimen provided were taken from. This might be that students have not been taught the topic or they were taught but have forgotten most of the things as a result of lack of revision. This topic is taught in first year in most schools and hardly do students revise them if it is not time for

examination. The specimens provided for test three (3) were taken from the topic “Life Processes of Living Things (1). The specimen provided were

A ---------- Adult Grasshopper D --------- Grain Weevil

B ---------- fern E ---------- Adult Cockroach

C ---------- Moss plant

This topic examined students’ understanding and knowledge in some life processes of some lower organisms and some insects of economic importance. It also assesses students understanding in the external features of some insects and how these features relate them to their functions to enable the organisms adapt to their habitat successfully. This topic is mostly taught in form one and students’ performance shows that most of them have forgotten what they were taught. Although, most of the specimens provided were familiar with students, their performance shows that they did not have enough time to revise for the test since they were concentrating on what they were being taught at that time.The mean score of the test (51.06%) also shows that although students were taught the topic in the first year, few students still remembered the content and were able to use it to performed the tasks.

When students were asked why they did not perform very well as expected of them, students gave responses such as:

> Martey in school B: “even though we have learnt about the specimen provided, I have forgotten some of the things about them especially the adaptive features”,
>
> Eric in school C: we don’t write test on biology practical so I don’t learn anything for practical work”
>
> Tetteh in school A:“I though the test was going to be on what we are learning currently so I did not revise this topic.”

> Sandra in school C: “Hmm, we have been taught the topic but everyday teachers are adding new things so I don’t get time to revise the ones learnt earlier”
>
> Gifty in school B: “we have not being writing test in biology practical so although we have been taught, I didn’t know what and what to learn for the test.

The results show that inability of students to constantly revise topics previously taught affects their performance in biology practical work. The results also showthat both teachers and students engage in biology practical work when students are in form three and are preparing for the WASSCE biology practical examination (Biology Paper Three). This finding confirms Antwi (2000), who found out that biology teachers did not conduct practical work especially at the lower levels of study but only engage in practical work with students when they are in form three and are preparing for their final examination.

The mean score of students’ in Test 4 was 33.61%. This indicates that students performed below average in this test. This performance of students in Test 4indicates that students lack in-depth knowledge in the topics from which the specimens provided were taken from. This is because most students have not been taught these topics which they confirmed during the interview section.

The specimens provided for the test were taken from the topics: “Anatomy and physiology of mammals” and “Seeds and fruits formation”. The specimens provided for the test were:

A ---------- Small intestine of a goat D ----------Tomato fruit

B ---------- Pineapple E ----------Orange fruit

C ----------Mango fruit

Anatomy and physiology of mammals assess students' ability to relate the internal organs of a mammal to their functions and how these organs are coordinated together for normal functioning of organisms. Fruits and seeds formation also examines students on structure and classes of different fruits and how they are formed. Anatomy and physiology of mammal is taught at the latter end of SHS 2 while fruit and seed formation is also taught at the early stages of SHS 3.

Practical activities on anatomy of mammals always required students to work with the internal organs of organisms which the students are not familiar with. This makes it difficult for students to identify the organs and work with them. Because students have not been taught and have not done any practical work on this topic, they were not able to identify the specimens and perform the tasks assigned during the test. This therefore made the students to performed below average in the test.

Although most students were familiar with the fruits provided as specimens they were still not able to answer the questions since almost all students confirmed that they have not been taught that topic. This indicates that familiarity of specimens to students alone is not enough to let students excel in practical work but in-depth knowledge about the specimen being studied is a major determining factor of students' performance in biology practical work. Students must have a broad knowledge about the specimen provided in the practical before they can perform well in practical work and this can only be gained after students have been taught the topic through series of practical activities.

Excerpts of the students' responses when they were asked why they performed below average in Test 4 are as follows:

> Elizabeth in school C: "the specimen was not new but what they were asking us about them were too difficult"
>
> Obeng in school A: "I think when they teach us the plants we can do well because we have not done anything on fruits."
>
> Emmanuel in school B: "the specimens were familiar but how to describe them was difficult"
>
> Emefa in School A: "I can see the specimens oo but I dint even know what to write as observable features."

This results show that even if students are familiar with specimensbutlack in depth knowledge about them, it goes a long way to affect their performance in practical work.

The results from all the tests indicate that performance of biology students in practical work depends mostly on the type of specimen provided and the topic from which the specimens provided for the practical are taken. The results show that if specimens provided are familiar and is within the immediate environment of students and the specimen are taken from topics that students are well acquainted with, they perform well in the that practical test. However, if specimens provided are not familiar with students and are taken from a topic which students lack in depth knowledge about it, students perform below average in such practical work. The results also show that if students are familiar with specimens provided but are from a topic that students lack an in depth knowledge about it or have not been taught, students still perform below average in that practical work. This also indicates that

teachers should constantly take students through practical work in order to enable them revise what they have been taught.

Students were graded based on their performance. This was to enable the meascertain the overall performance of students in all the test. In this study, the grading system used in grading students was adopted from the Ministry of Education teaching syllabus for elective biology (2010). The grading system was

Score	**Grade**	**Interpretation**
80------- 100	A1	Excellent
75 --------79	B2	Very good
70 --------74	B3	Good
65 ---------69	C4	Credit
60 ---------64	C5	Credit
50 ----------59	C6	Credit
45 ----------49	D7	Pass
44 -----------40	E8	Weak pass
39 0	F9	Fail

The summary of students grades is shown in Table 2.

Table 2-The *grades of students in the biology practical performance tests*

Number students	Score	Grade	Interpretation
0	80 -------100	A1	Excellent
0	75 --------79	B2	Very Good
3	70 -------74	B3	Good
7	65 --------69	C4	Credit
5	60 --------64	C5	Credit
25	50 --------59	C6	Credit
13	45 -------- 49	D7	Pass
10	44 --------40	E8	Weak pass
27	39 ----------0	F9	Fail

Number of Respondents = 90

From Table 2, the results indicate that no student obtained the grades A1and B2. The results show that three students have B3 as the best grade and 27 students have F9 as the worst grade.

Based on the scores and grades obtained by the students, the overall performance of students was described under three main levels. These were: 'Above average', 'Average' and 'Below Average'. Performance of students who obtained the grades A1-------B3 were describedas "Above average", students who obtained the grades C4 -------C6 were described as "Average" and students who obtained the grades D7 ---------F9 were described as"Below Average". Summary of students' overall performance is shown in Table 3

Table 3-*Description of overall performance of students in the biology practical performance test*

Number of students	Scores	Grades	Description
3	70 --------100	A1 ------B3	Above Average
37	50 ---------69	C4 -------C6	Average
50	0 -----------49	D7 -------- F9	Below Average

Number of Students = 90

From Table 3, the results show that most of the students obtained the grades D7 ----F9. This shows that majority of students performed below average in the test. This indicates that biology students within the Ledzokuku Municipality performed below average in biology practical test.

The comments students gave in response to why their performance was below average include:

> Eugene in school B: "the school do not have laboratory; the same classroom that we are in serves as laboratory, it doesn't make us do practical"
>
> Gifty in school A:"we have not written any test in practical before so the whole thing was new to us"
>
> Francis in school C: "we have not done practical before, when we asked our teacher when we are going to do practical, he always says that there is no time because the things to study are many."

From the results, students attributedtheir below average performance in the biology practical work to factors such as lack of laboratory, time constraints and the overloaded curriculum.

Research question Two:

What are the mean scores of students in the biology practical tasks in each of the four test?

Research question two was meant to investigate the mean score of students in each task assigned during the four tests. The mean scores of students in each taskswere obtained and analyzed.

The summary of result of mean scores of students is shown in Table 4.

Table 4-*Distribution of the mean scores of students in each task in test one*

Task	Mean score (%)	Std. deviation	Std. error
Observation	86.67	20.933	2.207
Classification	42.50	31.006	3.268
Habitat	93.61	12.179	1.284
Drawing	33.33	20.527	2.164
Adaptive Features	55.00	30.949	3.262

Number of respondent (N): 90 students

The results in Table 4, show that Habitat had the highest mean of 93.61% followed by Observation with a mean of 86.67%. Adaptive features followed with an average mean of 55.00%. Classification followed with a lower mean of 42.50% and drawing came last with a least mean of 33.33%.

The results indicated that students performed above average in the Habitat and Observation task. Students' performance was average in the adaptation task with the performance of students in the Classification and Drawing tasks being below average.

Students performing above average in the habitat task in this test shows that almost all the students who wrote the test were able to provide correct

names of the habitats of the specimens provided. They were also able to spell these names correctly. This result was achieved because the specimens used in the test were located in their immediate environment. and are familiar with where they live and can be found so providing the habitat names for these specimens was not challenging to students. A mean score of 86.67% of students in the Observation task showed that students performed above average. The results show that students can critically observe specimens and come out with their observable features without any difficulty. The performance might be the fact that the specimens provided were large enough so students were able to observe all the vital parts without any difficulty hence enhancing their performance in the Observation task. An average mean score of 55.00% in the Adaptation task shows that students performed averagely in the Adaptation task. This shows that students have quite a clear knowledge on how the structures of and organism are related to their functions. A lower mean score of 42.50% in the classification task shows that most students have difficulties in classifying specimens. This performance of students which was below average might be the fact that most students were not able to spell correctly the names of the taxa of the provided specimens and students did not start the names of these words with capital letters as stated as part of the rules of classifying specimens. The results of the interview showed that students have difficulties in spelling words such as Osteithchyes, Amphibia, Reptilia and Mammalia. This difficulties of students in spelling scientific words correctly affected their performance in the classification task. This finding support the Chief Examiners'report (2015), which stated that the word

‘Ostiechthyes’ is constantly spelled wrong by most students any time it comes in the WASSCE biology practical examination.

A mean score of 33.33% indicates below average performance of students in the Drawing task. Although the specimens provided were big enough for students to observe and draw, most students were not conversant with how to observe and draw at the same time since they have not been practicing biological drawing. The major cause of this performance of students in the drawing task was their inability to provide correct titles for the specimen drawn and not able to calculate and provide magnification for the specimen drawn.

Distribution of mean score of students in each task in test two is shown in Table 5

Table 5-*Distribution of mean scores of students in each task in test two*

Task	Mean score (%)	Std. deviation	Std. error
Observation	61.39	27.834	2.934
Classification	16.94	22.117	2.331
Habitat	51.94	20.943	2.208
Drawing	27.50	18.757	1.977
Adaptation	18.06	22.805	2.404

From Table 5, the results indicate that Observation task recorded a higher mean score of 61.39% and Classification task recorded a least mean score of 16.94%

The results show that students’ performance in observation task and Habitat task was average with Students’ performing below average in Drawing task, Adaptation task and classification task.

A mean score of 61.39% in theobservation task in test two showed that although the specimens provided were not familiar with students, they well still able to observe them well and come out with the observable features. This showed that familiarity of specimen does not matter in Observation task. Once the specimens were in front of students, most students were able to critically observe some features such as colour, size, shape and texture.

A mean score of 51.94% in the habitat task showed that students have a fair idea of the habitats of the specimens provided. The results of the interview showed that although students did not know the specific habitats of some of the specimens provided, they used the general idea of where plants can be found in providing the habitats for the specimens. A mean score of 27.05% indicated that students' performance in the Drawing task was below average. The results showed that although most students were able to draw the leaf itself, most diagrams were not within the correct range of measurement that students were asked to draw the specimen. Most of the students were not able to provide the title, magnification and correct labels for the drawn specimen. A mean score of 18.06% in the adaptation task also showed that students performed below average. This showedthat students lacked in-depth knowledge about the specimens provided. Students, since they did not have much knowledge about the specimens, they could not relate the structures of the specimens to their major functions. This was confirmed during the interview when they lamented that they have not been taught anything on plants yet.

Students performed below average in the Classification task. A mean score of 16.94% showed that majority of students could not classify the specimens provided into their respective divisions. The results of the interview showed that most students did not know the division of the specimens provided and the few students who attempted were not able to spell words correctly or did not start the words with capital letter as the rule prescribes. Most students were not able to spell correctly the words 'Monocotyledonae' and 'Dicotyledonae.' This confirmed WAEC'S(2015) report which reported that most students were not able to spell these two words correctly.

Distribution of mean score of students in test three is shown in Table 6

Table 6-*Distribution ofthe mean scores of students in each task in test three*

Task	Mean score (%)	Std. deviation	Std. error
Observation	73.61	19.603	2.066
Classification	33.33	23.404	2.467
Habitat	72.50	17.993	1.897
Drawing	30.56	16.667	1.757
Adaptation	42.50	23.835	2.512

Number of Respondents (N): 90

The results in Table 6 show that students performed above average in Observation task and Habitat task below average in Classification task, Drawing task and Adaptation task.

Students performing above average in Observation task showed that most students were able to observed and come out with the observable features of the provided specimens without much difficulties. Students

performing above average in Habitat task showed that most students were able to provide the correct habitat for the specimens provided.

The performance of students in the adaptation task showed that most students were not able to relate the structures of the specimens to their correct functions. This showed that students lack in depth knowledge on the specimens provided and the topic from which the specimens were taken from. Students' performance in the Classification task showed that students still have problem with the correct spelling and writing of scientific terms used in classifying specimens. Performance of students in drawing task also showed that students were not able to follow the procedures involved in biological drawing of specimens such as correct size, poor labelling and wrong magnification.

Mean score of students in each task in test four is shown in Table 7

Table 7-*Distribution ofthe mean scores of students in each task in test four*

Task	Mean score (%)	Std. deviation	Std. error
Observation	43.61	20.718	2.184
Classification	11.11	15.502	1.634
Habitat	66.11	18.094	1.907
Drawing	32.50	19.635	2.070
Adaptation	11.39	18.036	1.901

From Table 7, the results indicate that students performed averagely in Habitat Task with students performing below average in Observation task, Classification task, Drawing task and Adaptation task.

From the result, it shows that students performed better in the Habitat task than all the other tasks. Students' performance in the habitat task was average with students performing below average in the Observation task and poorly in the Drawing task. However, students' performance was very poor in the Adaptation and the Classification task respectively.

An average performance of students in Habitat task showed that some students are still able to give correct habitat names of specimens provided. The performance in Observation task showed that most students this time were not able to give the observable features of the specimens provided. This was because students did not know the names of the observable features of the specimen provided although they were able to see them. The performance in drawing task showed that students are still not conversant with principles of biological drawing. Students' performance in adaptation task showed that majority of the students were still not able to relate the structures of the specimens provided to their correct functions. Classification task still remains a problem to students as most students are not conversant with scientific terms used in classifying specimens.

The mean scores of students in all the task in the four test were compared and the mean scoreis shown in Table 8.

Table 8-*Comparison ofthe mean scores of students in the tasks in all the four tests*

Task	Mean scores of tasks in the four test (%)				
	Test one	Test two	Test three	Test four	Ave.mean
Observation	86.67	61.39	73.61	43.61	66.32
Classification	42.50	16.94	33.33	11.11	25.97
Habitat	93.61	51.94	72.50	66.11	71.04
Drawing	33.33	27.50	30.56	32.50	30.97
Adaptation	55.00	18.06	42.50	11.39	31.74

Number of respondents (N) = 90

From Table 8, the results showed that maximum mean score of 86.6% and minimum mean score of 43.61% were scored in the observation task. A maximum mean score of 42.50 and a minimum score of 11.11% were scored in the classification tasks. A maximum mean score of 93.61% and a minimum mean score of 51.94% were also scored in the habitat tasks. Students also scored a maximum mean score of 33.33% and a minimum mean score of 27.50% in the drawing tasks. A maximum mean score of 55.00% and a minimum mean score of 11.39% were also score by students in the adaptation tasks.

The results show that students' performance in the habitat task was above average. This indicated that students were able to provide the specific habitat for a given varieties of specimens ranging from plants to animals without difficulties. An average mean score of 66.32% was scored by students in the observation task. This showed that students performed averagely in observing specimens and coming out with their observable features. This

showed that students may have some challenges in observing certain specimens and coming out with their observable features. The size of specimen provided can affect students' performance in observation task. When the specimens provided are smaller in size, students are not able to observe clearly all the parts and come out with them but when the specimens provided are big enough, all the parts are well exposed so students are able to easily observe them and come out with the needed parts.

An average mean score of 31.74% was scored by students in the adaptation task. This showed that students performed below average in performing adaptation task during biology practical work. This performance showed that students lack the knowledge to relate structures of given specimens to their functions. This also indicates that students lack in depth knowledge in their biological concepts.

The results also show that students have great difficulties in biological drawing of specimens. Most of the drawings presented by students during the tests were just free hands sketching and did not have any features of biological drawing. Apart from the inability of students to calculate magnifications, most students were not able to draw the specimens to the size given to them, write correct titles and labels. This finding supports the WAEC's (2015) report which commented that the diagrams of most students were lacking major parameters of biological drawings such as title, labels, magnifications and clarity of lines. In the report, teachers were asked to take students through a lot of biological drawings as part of their preparation towards the practical examination. An average mean score of 25.90% was scored by students in the classification task. This showed that students have

much difficulties in classifying specimens into their respective taxa under the natural system of classification. Most students were not able to spell correctly the scientific terms used in classifying organisms. The results of the interview confirmed that words such as Monocotyledonae, Dicotyledonae, Osteithchyes, Oligochaeta, Amphibia, Arthropoda were wrongly spelled by majority of students. Also, in writing the names of the scientific terms, most students did not start with capital letter and this caused a lot of students to lose a lot of marks in the classification task. This finding also Supports the WAEC's (2014 & 2015) reports, which stated that most students were not able to spell most of the scientific terms used in classifying specimens. Examples were Monocotyledonae, Dicotyledonae, Coelenterate and Reptilia.

Students' performance in the various tasks assigned to them during the test was ranked. The result of the ranking is shown in Table 9

Table 9-*Ranking of task assigned to students based on their Performance*

No	Task	Students' performance
1	Habitat	Above Average
2	Observation	Average
3	Adaptation	Below Average
4	Drawing	Below Average
5	Classification	Below Average

Students' performance shows that Habitat and Observation tasks are well performedby students whilesstudents have difficulties in performing Adaptation task, Drawing task and Classification task.

The results show that the strength of biology students in practical work lies in the Habitat task and the Observation task. However, students' weakness in practical work lies in the Adaptation task, the Drawing task and the Classification task respectively. Much attention should be given to these challenges by teachers during their lessons.

Research Question Three

To what extent does the mean scores of male students in the biology practical tasks in the four tests different from those of the female students?

Research question three was meant to investigate how the performanceof males and females differ from each other in the tasks assigned to them.

Summary of the distribution of mean scores of males and females is shown in Table 12

Table 12-*Distribution of mean scores of males and females in the biology practical test*

Test	Mean score		Mean scores	
	Males	Std. dev.	Females	Std. dev.
Test one	64.42	14.708	59.08	19.927
Test two	39.42	16.077	35.66	19.493
Test three	53.46	14.704	48.68	16.550
Test four	35.10	13.191	31.55	13.809
Ave. mean	48.10	14.67	43.74	17.44

Males = 52 Females = 38

From Table 12, the results show that males obtained higher mean scores in all the fourtests than females. The highest mean score of males was

64.42% and their lowest mean score was 35.10%. The highest mean score of females was 59.08% and their lowest mean score was 31.55%.

The results showed that the scores of the male students in the four test were consistently higher than that of their female counterparts. This showed that males perform better than females in the biology practical work. The result indicated that sex of students was a significant factor in students' performance in biology practical work. This finding agrees with the research work by Staberg (1985), on achievement of male and female students in biology practical work.He found out that males performed better than females when they were taught with the practical method. Similar results were obtained by other researchers (Stanwhort, 1983; Eliot 1984). The researchers found out that boys were more active during biology practical work than girls.

The mean score of males and females in all the tasks were also determined. The summary of the results is shown in Table 13.

Table 13-*Distribution of mean scores of male and femalestudent's performance in the biology practical tasks*

Task	Mean score (%)		Mean score (%)	
	Males		Females	
	Mean	Std. Dev	Mean	Std. Dev
Observation	68.415	14.8709	61.368	19.5441
Classification	26.946	19.3171	26.321	20.9405
Habitat	74.544	12.1771	70.263	17.0688
Drawing	34.400	11.9022		29.468
	13.7015			
Adaptation	32.840	17.4113	27.816	16.8040

Males = 52, Females = 38

From Table 13, the results show that males obtained a higher mean scores in all the five tasks assigned than females. This shows that males performed better than females in all the five task assigned to them. This might

be as a result of the fact that the number of males who took the test were more than the number of females. This might also be the fact that the males were ahead of females in terms of knowledge on the specimens used in the tests than the females. Males scored a highest mean score of 74.544% in Habitat task and a lowest mean score of 26.946% in classification task. Females also scored a highest mean score of 68.263% in habitat task and a lowest mean score of 26.321% in the classification task. This showed that the strength of both males and females in the biology practical was in the habitat task and their weakness was in the classification task.

Testing of Research Hypothesis one

Ho: There is no significant difference in the mean scores of students in the biology practical tasks assigned in the four tests.

In order to determine whether there is a significant difference in the mean score of students in the various tasks assigned during the practical work, the Analysis of Variance (ANOVA) one way was used. The set alpha value for the test was set at $p < 0.05$. The result of the test is shown in Table 10.

Table 10- *Analysis of Variance of students' performance in the tasks performed by students in the tests*

Source of variation	sum of squares	df	mean of squares	F	Sig. p	Remark
Between Groups	1097.333	4	274.333	65.095	0.000	Sig
Within Groups	358.222	85	4.214			
Total:	1455. 556	89				

From Table 10, p-value of 0.000 is less than the set alpha value of 0.05. This means that there is a significant difference in the mean score of students in the tasks assigned to them during the biology practical test. We therefore reject the null hypothesis and conclude that there is a significant difference in the mean score of students in the practical tasks assigned to them during the biology practical test. Since there is a significant difference, post hoc test was done to see where the difference actually occurs. The difference may be as a result of the content and scoring rubrics in each task which varies, therefore this may lead to the differences in students' performance. Summary of the result is shown in Table 11.

Table 11-*Scheffe's test showing Paired statistics of the various tasks assigned in the tests*

Pair	Task	Mean	Mean difference
1	Observation	66.32	40.42
	Classification	25.90	
2	Observation	66.32	4.72
	Habitat	71.04	
3	Observation	66.32	35.35
	Drawing	30.97	
4	Observation	66.32	35.28
	Adaptation	31.04	
5	Classification	25.90	45.14
	Habitat	71.04	
6	Classification	25.90	5.07
	Drawing	30.97	
7	Classification	25.90	5.14
	Adaptation	31.04	
8	Habitat	71.04	40.7
	Drawing	30.97	
9	Habitat	71.04	40.0
	Adaptation	31.04	
10	Drawing	30.97	0.07
	Adaptation	31.04	

The result in Table 11 shows that, the difference in mean scores occurs in Observation and Habitat and Classification, Drawing and Adaptation.

Testing of Research Hypothesis Two

Ho: There is no significant difference in the mean scores of male students and female students in the biology practical tasks in the four test.

The independent sample t- test was used to compare the mean scores of males and females in each of the task assigned during the tests to find out if there is a significant difference in their performance in the task assigned. The set alpha value for the test was set at $p \leq 0.05$.

Summary of the result is shown in Table 14.

Table 14-*t- test analysis of male and female students' performance in the observation task*

Gender	Mean	t-value	df	Sig (2-ta)	Mean diff
Male	68.415	1.943	88	0.055	7.047
Female	61.368				

Male =52, Females = 38

At degree of freedom of 88, the mean score of males (68.415) was higher than that of females(61.368). A t-value of 1.943 at 88 degree of freedom gave a p-value of 0.055. Since the p-value of 0.055 is higher than the set alpha value of 0.05,the null hypothesis was accepted and was concluded that there is no significant difference between the performance of males and females in the Observation task assigned in the biology practical work.

The summary of males and females'performance in Classification task is shown in Table 15.

Table 15-*t-test analysis of male and female students' performance in classification task*

Gender	Mean	t-value	df	Sig (2-tail)	Mean diff
Male	26.946	0.146	88	0.884	0.625
Female	26.321				

Males = 52, Females = 38

The mean score of males (26.946) was higher than that of females (26.321). A t-value of 0.146 at 88 degree of freedom gave a p-value of 0.0884. Since the p-value of 0.884 is higher than the set alpha of 0.05, it was concluded that there was no significant difference between males and females' performance in the classification task assigned during the biology practical tests.

Summary of males and females' performance in Habitat task is shown in table 16

Table 16: *t-test analysis of male and female students' performance in habitat task*

Gender	Mean	t-value	df	Sig (2-tail)	Mean diff.
Male	74.544	2.039	88	0.059	4.320
Female	70.263				

Males 52, Females 38

The mean score of males (74.544) was higher than that of females (70.263). A t-value of 2.039 at 88 degree of freedom gave a p-value of 0.059.Since the obtained p-value of 0.059 is greater than the set alpha value of 0.05, it was concluded that there was no significant difference between the performance of male and female in the habitat task assigned to students during

the test.Therefore, we accept the null hypothesis and conclude that there is no significant difference in the performance of males and female's students in the performance task assigned during the biology practical test.

Summary of males and females' performance in the Drawing task is shown in Table 17.

Table 17-*t-test analysis of male and female students' performance in the drawing task*

Gender	Mean	t-value	df	Sig (2-tail)	Mean diff
Male	34.400	1.821	88	0.072	4.932
Female	29.468				

Male =52, Female =38

The mean scores of males which is 34.400 was higher than that of females which is 29. 468. A t- value of 1.821 at 88 degree of freedom gave a p-value of 0.072.Since the p-value of 0.072 is higher than the set alpha value of 0.05, it was concluded we accepted the null hypothesis and concluded that there was no significant difference between the mean scores of male's and female's students in the Drawing task that was assigned to studentsduring the biology practical tests.

The summary of males and females students' performance in the Adaptation task is shown in Table 18.

Table 18-*t-test analysis of male and female students' performance in the adaptation task*

Gender	Mean	t-value	df	Sig (2-tail)	Mean diff
Male	32.840	1.372	88	0.174	5.024
Female	27.816				

From table 18, the mean score of males (32.840) is higher than females (27.816).A t- value of 1.372 at 88 degree of freedom gave a p-value of 0.174. Since the p-value of 0.174 is higher than the set alpha value of 0.05,the null hypothesis was accepted. It was therefore concluded that there was no significant difference in the performance of male and female students' in the Adaptation task assigned to students during the tests.

This result agrees with the findings of (Ibitoye, 1998 and Abonyi, 1998) who found no significant difference in the performance of males and females in practical work in science.

Summary of Major Findings

From the results of the study, the following findings were recorded

1. From the study, it was foundthat the biology students within the Ledzokuku municipality performed below average in biology practical test. The major factors identified as the cause of this poor performance of students in biology practical work are lack of laboratories and inadequate practical lessons
2. It was also found that the performance of students in biology practical work depended on the type of specimens provided and the topic from which the specimens provided were taken from. It was seen that when students are familiar with the specimens provided and the specimens are taken from topics that they have been taught, they perform better than when the specimens provided are not familiar and are taken from topic that they have not been taught.
3. It was also found that, the performance of the students in biology practical work depended on the task assigned to the students in the practical work.

It was seen that students performed above average in Habitat task and averagely in Observation task but performed below average in Adaptation, Drawing and Classification tasks

4. The results showed that, males performed better than the females in biology practical work butthe difference in performance wasnot statistically significant
5. From the study, it was also seen that, there is no significant difference in the performance of males and females in the tasks assigned to students during the Biology Practical Performance Test.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Overview

This chapter presents the summary of the whole work and the conclusion drawn from the work. Also present are recommendations made from the study and suggestions for further research.

Summary of work

The study was an investigation of the level of performance of Senior High School Biology Students in Practical work in the Ledzokuku Municipality in the Greater Accra Region of Ghana.90 students were randomly selected from three senior high schools within the municipality. In thestudy, the mixed method approach was employed and the descriptive survey design was used in the study. In the study, performance test and semi-structured interview were used in collecting data. The instrument for data collection, 'Biology Practical Performance Test (BPPT 1-4) was self-developed by the me based on four major topics from the elective biology teaching syllabus for senior high schools in Ghana. Based on these four topics, four different tests were developed by me and validated by senior biology tutors and the supervisors.

Test 1 consisted of specimens taken from the topic 'Life Processes of Living things (2), test 2 consisted of five items taken from the topic 'Plant Structure and Physiology, test 3 also consisted of five items taken from the topic 'Life Processes of living things (1) and test 4 consisted of five items taken from the topics 'Anatomy and Physiology of Mammals and Fruit and

Seeds formation. All the tests were pilot tested and a reliability co-efficient of 0.72 was obtained.

Students were provided with five different specimens and were asked to perform five different tasks using the specimens provided within 30 minutes. The task performed by students were Observation task, Classification task, Drawing task, Adaptation task and Habitat task. Each test was scored over 20 marks and a student scores 4 marks for successful completion of one task. Students were interviewed after each task to find out their opinions on the task. The data collected was analysed using Means, Standard deviation, ANOVA and independent sample t-test. Results from the interview was also transcribed thematically.

Results from the study showed that majority of the biology students within the Ledzokuku Municipality performed below average in biology practical work. The results also show that the performance of students differ from task to task. The results showed that students performed above average in Habitat task, averagely in Observation task and below average in Adaptation task, Drawing task and Classification task. The results from the study also showed that, the performance of males is slightly above that of females in biology practical work. The results also show that there is no significant difference in the performance of males and females in each of the task assigned to students during the biology practical performance test.

Conclusions

The study has shown that biology students within the Ledzokuku municipality performed below average in biology practical work. This could be that students do not go through a lot of practical activities during their

biology lessons or their schools lack the necessary apparatus and equipment for conducting effective biology practical work. The study has also shown that students performed below average in the Adaptation task, the Drawing task and the Classification task. This could also be due to the fact that most students lacked in-depth knowledge in the various topics from which the specimens were taken from hence their inability to perform well. Poor performance of students in the Drawing task could be due to the fact that students did notoften draw biological specimens during their biology lessons.Students also performed below average in Classification task. This could be due to the students' inability to pronounce the scientific terms correctly causing them to spell the terms wrongly.

This study has provided insights into some factors that affected students' performance in biology practical work. These included the; type of specimens provided during the practical work, the topic from which the specimens were selected for the practical work and the type of task assigned to students during practical work.

Recommendations

From the findings and the conclusions, it is recommended that:

1. Biology teachers should take students through a lot of practical activities to help improve students' performance in practical work.
2. Biology teachers should incorporate practical activities such as demonstrations, projects and field trips into their teaching to help enhance students' performance in practical work.
3. Biology teachers should take their students through a lot of tutorials on biological drawings to help improve their drawing skills. Students should

be taught how to calculate magnifications and writing titles as part of the tutorials

4. Students should be taught how to relate structures of an organism to their respective functions.

Suggestions for Further Research

This research can serve as the basis for other researchers who wish to investigate further into other factors that affect students' performance in biology practical work.

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APPENDICES

APPENDIX A

RESULTS OF THE BIOLOGY PRACTICAL PERFORMANCE ASSESSMENT TEST

Serial number	Sex	Test one	Test two	Test three	Test four	Average	Grade
1	Male	55	30	50	35	42.5	E8
2	male	55	20	55	45	43.8	E8
3	female	20	15	40	25	25.0	F9
4	female	35	15	25	15	22.5	F9
5	male	60	45	55	30	47.5	D7
6	male	65	25	60	35	46.3	D7
7	male	65	35	50	45	48.8	D7
8	male	65	50	60	40	53.8	C6
9	male	85	70	60	65	70.0	B3
10	male	80	45	65	40	57.5	C6
11	female	45	25	30	20	30	F9
12	male	55	35	55	45	47.5	D7
13	female	60	40	70	40	52.5	C6
14	female	70	25	65	40	50	C6
15	female	70	50	60	55	58.75	C6
16	male	70	40	65	45	55	C6
17	male	80	65	75	45	66.25	C4
18	female	80	60	70	60	67.5	C4
19	male	50	25	55	45	43.75	E8
20	female	85	65	70	65	71.25	B3
21	male	60	30	50	40	45	D7
22	female	60	45	55	40	50	C6
23	female	65	50	50	35	50	C6
24	male	55	45	65	30	48.8	D7
25	male	40	25	35	35	51.3	C6
26	male	40	15	25	20	25	F9
27	female	80	45	40	10	43.8	E8
28	male	70	40	55	25	47.5	D7
29	male	50	25	35	15	31.3	F9
30	male	60	25	45	20	37.5	F9
31	female	80	65	55	40	60	C5
32	male	80	50	65	40	58.8	C6
33	male	85	70	75	60	72.5	B3
34	male	65	50	55	35	51.25	C6
35	male	80	40	65	45	57.5	C6
36	female	65	45	55	30	48.8	D7
37	male	75	55	50	40	55	C6
38	female	70	50	45	40	51.3	C6
39	female	85	60	65	45	63.8	C5
40	male	75	35	50	25	46.3	D7
41	female	35	10	45	15	26.3	F9
42	male	45	20	40	15	30	F9

43	**male**	**60**	**45**	**50**	**25**	**45**	**D7**
44	**male**	**70**	**50**	**60**	**45**	**56**	**C6**
45	**female**	**70**	**45**	**50**	**20**	**46.3**	**D7**
46	**female**	**65**	**30**	**55**	**25**	**43.8**	**E8**
47	**male**	**80**	**65**	**70**	**40**	**63.8**	**C5**
48	**male**	**85**	**55**	**75**	**50**	**66.3**	**C4**
49	**female**	**50**	**35**	**45**	**25**	**38.8**	**F9**
50	**male**	**40**	**30**	**40**	**35**	**36.3**	**F9**
51	**female**	**75**	**60**	**65**	**35**	**58.8**	**C6**
52	**male**	**70**	**40**	**60**	**30**	**50**	**C6**
53	**male**	**80**	**45**	**70**	**15**	**52.5**	**C6**
54	**male**	**85**	**70**	**70**	**50**	**68.8**	**C4**
55	**male**	**80**	**65**	**60**	**40**	**61.3**	**C5**
56	**female**	**75**	**45**	**65**	**40**	**56.3**	**C6**
57	**male**	**70**	**30**	**55**	**15**	**42.5**	**E8**
58	**female**	**45**	**10**	**35**	**15**	**26.3**	**F9**
59	**female**	**45**	**20**	**40**	**45**	**37.5**	**F9**
60	**male**	**75**	**40**	**60**	**25**	**50**	**C6**
61	**male**	**50**	**20**	**50**	**35**	**38.75**	**F9**
62	**female**	**55**	**45**	**50**	**25**	**43.75**	**E8**
63	**female**	**50**	**20**	**55**	**30**	**38.75**	**F9**
64	**female**	**55**	**30**	**50**	**25**	**40**	**E8**
65	**male**	**45**	**15**	**35**	**15**	**27.5**	**F9**
66	**female**	**20**	**0**	**20**	**10**	**12.5**	**F9**
67	**male**	**40**	**15**	**20**	**20**	**23.75**	**F9**
68	**female**	**45**	**20**	**15**	**35**	**28.75**	**F9**
69	**male**	**55**	**25**	**50**	**35**	**41.25**	**E8**
70	**male**	**85**	**60**	**75**	**50**	**67.5**	**C4**
71	**female**	**20**	**5**	**10**	**15**	**12.5**	**F9**
72	**female**	**75**	**40**	**60**	**35**	**52.5**	**C6**
73	**male**	**40**	**10**	**20**	**10**	**20**	**F9**
74	**male**	**65**	**35**	**65**	**40**	**51.25**	**C6**
75	**male**	**50**	**35**	**25**	**20**	**32.5**	**F9**
76	**female**	**25**	**5**	**30**	**15**	**18.75**	**F9**
77	**male**	**65**	**40**	**50**	**35**	**47.5**	**D7**
78	**female**	**80**	**55**	**65**	**40**	**60**	**C5**
79	**male**	**70**	**35**	**40**	**35**	**45**	**D7**
80	**female**	**85**	**60**	**65**	**45**	**63.75**	**C5**
81	**male**	**85**	**65**	**70**	**55**	**68.75**	**C4**
82	**female**	**85**	**65**	**70**	**50**	**67.5**	**C4**
83	**female**	**55**	**30**	**35**	**25**	**36.25**	**F9**
84	**male**	**35**	**15**	**20**	**10**	**20**	**F9**
85	**female**	**80**	**45**	**65**	**30**	**55**	**C6**
86	**male**	**75**	**50**	**65**	**45**	**58.75**	**C6**
87	**male**	**75**	**45**	**60**	**40**	**55**	**C6**
88	**male**	**55**	**40**	**45**	**35**	**43.75**	**E8**
89	**female**	**45**	**10**	**40**	**25**	**30**	**F9**
90	**female**	**40**	**15**	**25**	**15**	**23.75**	**F9**

APPENDIX B

DISTRIDUTION OF STUDENTS SCORES IN THE VARIOUS TASKS IN TEST ONE

Serial number	Observation (100)	Classification (100)	Habitat (100)	Drawing (100)	Adaptation (100)
1	75	25	75	25	75
2	100	50	75	25	25
3	50	0	50	0	0
4	50	25	75	0	25
5	50	50	100	50	50
6	100	50	75	50	50
7	75	50	75	50	75
8	100	25	100	25	75
9	100	75	100	50	75
10	100	50	100	50	100
11	50	0	100	25	50
12	100	25	100	25	25
13	75	50	75	25	50
14	75	50	100	50	75
15	100	75	100	25	50
16	75	75	100	25	75
17	100	75	100	50	75
18	100	75	100	50	75
19	75	25	75	50	25
20	100	75	100	50	75
21	75	50	100	25	50
22	75	25	100	50	50
23	100	25	100	25	75
24	75	50	100	0	50
25	75	0	75	25	25
26	75	25	50	0	50
27	100	50	50	25	100
28	75	75	100	25	50
29	75	25	100	25	25
30	100	0	100	50	50
31	100	75	100	50	75
32	100	100	100	25	75
33	100	75	100	75	75
34	100	50	100	50	25
35	100	75	100	50	75
36	50	50	100	50	100
37	100	25	100	25	75
38	100	50	100	50	50
39	100	75	100	50	100
40	100	25	100	0	100
41	75	0	75	25	25

42	**75**	**0**	**100**	**50**	**25**
43	**100**	**0**	**100**	**50**	**50**
44	**100**	**25**	**100**	**50**	**75**
45	**100**	**50**	**100**	**25**	**75**
46	**75**	**75**	**100**	**0**	**75**
47	**100**	**75**	**100**	**50**	**75**
48	**100**	**100**	**100**	**50**	**100**
49	**100**	**25**	**75**	**50**	**0**
50	**75**	**25**	**100**	**25**	**25**
51	**100**	**50**	**100**	**50**	**75**
52	**100**	**50**	**100**	**25**	**75**
53	**100**	**50**	**100**	**50**	**100**
54	**100**	**75**	**100**	**50**	**100**
55	**100**	**100**	**100**	**50**	**100**
56	**100**	**100**	**100**	**50**	**75**
57	**100**	**50**	**100**	**25**	**75**
58	**75**	**25**	**100**	**25**	**0**
59	**75**	**25**	**75**	**25**	**25**
60	**75**	**25**	**100**	**75**	**100**
61	**100**	**0**	**75**	**25**	**50**
62	**100**	**0**	**100**	**0**	**75**
63	**75**	**25**	**100**	**0**	**50**
64	**75**	**25**	**100**	**50**	**25**
65	**75**	**0**	**75**	**50**	**25**
66	**0**	**0**	**100**	**0**	**0**
67	**75**	**0**	**100**	**25**	**0**
68	**75**	**0**	**100**	**0**	**50**
69	**100**	**25**	**100**	**25**	**25**
70	**100**	**100**	**100**	**0**	**100**
71	**0**	**0**	**100**	**25**	**0**
72	**100**	**50**	**100**	**25**	**100**
73	**75**	**0**	**100**	**25**	**0**
74	**100**	**25**	**100**	**25**	**75**
75	**100**	**25**	**100**	**25**	**0**
76	**25**	**25**	**75**	**0**	**0**
77	**100**	**50**	**100**	**25**	**50**
78	**100**	**75**	**100**	**25**	**100**
79	**100**	**100**	**100**	**0**	**50**
80	**100**	**100**	**100**	**75**	**75**
81	**100**	**75**	**100**	**75**	**100**
82	**100**	**75**	**100**	**50**	**100**
83	**100**	**25**	**75**	**25**	**50**
84	**100**	**0**	**75**	**0**	**0**
85	**100**	**75**	**100**	**50**	**75**
86	**100**	**100**	**100**	**0**	**75**
87	**100**	**75**	**100**	**50**	**50**
88	**100**	**0**	**75**	**25**	**75**
89	**100**	**0**	**100**	**0**	**25**

90	**75**	**0**	**75**	**25**	**25**

APPENDIX C

DISTRIDUTION OF STUDENTS SCORES IN THE VARIOUS TASKS IN TEST TWO

Serial number	Observation (100)	Classification (100)	Habitat (100)	Drawing (100)	Adaptation (100)
1	50	0	26	50	0
2	50	0	25	25	0
3	50	0	0	25	0
4	25	0	0	0	0
5	75	25	50	25	50
6	75	0	50	0	0
7	75	25	25	25	25
8	100	25	75	25	25
9	100	50	75	50	75
10	75	25	50	25	50
11	75	0	25	0	25
12	50	25	75	25	0
13	75	25	25	25	50
14	75	0	0	25	25
15	75	25	75	25	50
16	75	0	75	50	0
17	50	50	75	25	50
18	100	50	75	25	50
19	75	0	50	0	0
20	75	50	100	25	75
21	75	0	50	25	0
22	75	0	75	25	10
23	75	50	75	25	25
24	75	0	100	0	50
25	75	0	50	0	0
26	0	0	50	25	0
27	75	25	100	25	0
28	75	25	75	25	25
29	75	0	25	25	0
30	50	0	50	25	0
31	100	50	75	50	25
32	75	25	75	50	0
33	100	50	50	25	75
34	75	25	75	50	0
35	50	25	75	25	0
36	75	25	75	25	25
37	75	25	75	25	50
38	75	0	75	50	50
39	75	50	75	25	50
40	75	0	50	25	0
41	0	0	50	0	0
42	25	0	75	0	0
43	75	25	50	50	0
44	75	0	50	25	25
45	50	25	50	50	25
46	75	0	50	0	0

47	**100**	**50**	**75**	**50**	**50**
48	**75**	**0**	**50**	**50**	**50**
49	**75**	**0**	**50**	**25**	**0**
50	**75**	**0**	**50**	**0**	**0**
51	**75**	**75**	**75**	**50**	**25**
52	**50**	**50**	**75**	**25**	**0**
53	**75**	**0**	**50**	**50**	**0**
54	**75**	**75**	**75**	**50**	**25**
55	**75**	**75**	**50**	**25**	**75**
56	**75**	**25**	**25**	**50**	**25**
57	**50**	**0**	**25**	**25**	**0**
58	**0**	**0**	**25**	**0**	**0**
59	**25**	**0**	**75**	**0**	**0**
60	**75**	**0**	**50**	**50**	**0**
61	**25**	**0**	**50**	**25**	**0**
62	**75**	**25**	**50**	**50**	**0**
63	**50**	**0**	**25**	**25**	**0**
64	**75**	**0**	**50**	**0**	**25**
65	**0**	**0**	**50**	**25**	**0**
66	**0**	**0**	**0**	**0**	**0**
67	**25**	**0**	**50**	**0**	**0**
68	**25**	**0**	**25**	**25**	**0**
69	**50**	**0**	**50**	**25**	**0**
70	**100**	**25**	**75**	**50**	**50**
71	**0**	**0**	**25**	**0**	**0**
72	**75**	**0**	**50**	**50**	**25**
73	**25**	**0**	**25**	**0**	**0**
74	**75**	**0**	**50**	**25**	**25**
75	**25**	**0**	**75**	**50**	**25**
76	**0**	**0**	**25**	**0**	**0**
77	**75**	**25**	**50**	**50**	**0**
78	**75**	**25**	**100**	**50**	**25**
79	**75**	**0**	**50**	**50**	**0**
80	**100**	**50**	**75**	**50**	**25**
81	**75**	**50**	**75**	**75**	**50**
82	**75**	**75**	**75**	**50**	**50**
83	**50**	**0**	**50**	**25**	**0**
84	**50**	**0**	**25**	**0**	**0**
85	**75**	**25**	**75**	**50**	**0**
86	**75**	**25**	**50**	**50**	**0**
87	**75**	**50**	**50**	**50**	**25**
88	**75**	**0**	**50**	**25**	**50**
89	**0**	**0**	**25**	**25**	**0**
90	**0**	**0**	**25**	**50**	**0**

APPENDIX D
DISTRIDUTION OF STUDENTS SCORES IN THE VARIOUS TASKS IN TEST THREE

Serial number	Observation (100)	Classification (100)	Habitat (100)	Drawing (100)	Adaptation (100)
1	75	50	75	25	25
2	75	75	50	25	50
3	75	0	50	25	50
4	50	0	50	0	25
5	75	50	75	25	50
6	75	50	50	50	75
7	75	25	50	0	75
8	75	50	75	25	75
9	75	75	75	25	50
10	75	75	75	50	75
11	50	0	50	50	0
12	75	25	75	25	50
13	75	50	100	50	75
14	75	50	75	25	25
15	75	50	75	50	50
16	75	25	100	50	75
17	100	50	75	25	75
18	100	50	100	25	50
19	75	50	75	25	50
20	75	75	100	50	50
21	75	25	75	25	50
22	75	50	75	25	50
23	75	50	75	0	50
24	100	25	75	50	75
25	50	0	75	25	25
26	25	0	75	25	0
27	75	25	75	25	0
28	50	25	100	25	50
29	25	25	50	50	25
30	75	25	50	25	50
31	75	50	75	50	25
32	75	50	100	50	50
33	100	50	100	50	50
34	75	50	75	25	50
35	100	75	75	25	50
36	100	50	75	25	25
37	75	25	75	25	50
38	50	25	75	50	25
39	75	50	75	50	75
40	100	25	75	50	0
41	50	25	75	25	50
42	75	25	50	25	0
43	50	0	100	50	50

44	**75**	**50**	**75**	**25**	**75**
45	**75**	**50**	**50**	**25**	**50**
46	**75**	**50**	**75**	**50**	**25**
47	**75**	**50**	**100**	**50**	**50**
48	**100**	**50**	**100**	**50**	**75**
49	**50**	**25**	**75**	**25**	**50**
50	**50**	**25**	**75**	**25**	**25**
51	**75**	**50**	**75**	**50**	**75**
52	**50**	**25**	**100**	**50**	**75**
53	**100**	**75**	**75**	**50**	**50**
54	**100**	**50**	**100**	**25**	**75**
55	**75**	**50**	**75**	**50**	**50**
56	**100**	**50**	**75**	**50**	**50**
57	**75**	**25**	**75**	**25**	**75**
58	**50**	**0**	**75**	**0**	**50**
59	**75**	**0**	**75**	**0**	**50**
60	**100**	**25**	**100**	**25**	**50**
61	**75**	**50**	**75**	**0**	**50**
62	**50**	**25**	**50**	**25**	**50**
63	**75**	**25**	**75**	**25**	**75**
64	**75**	**50**	**50**	**25**	**50**
65	**50**	**0**	**50**	**25**	**50**
66	**50**	**0**	**50**	**0**	**0**
67	**25**	**0**	**75**	**0**	**0**
68	**50**	**0**	**25**	**0**	**0**
69	**75**	**25**	**75**	**50**	**25**
70	**100**	**75**	**100**	**50**	**50**
71	**25**	**0**	**25**	**0**	**0**
72	**100**	**50**	**75**	**25**	**50**
73	**50**	**0**	**50**	**0**	**0**
74	**100**	**25**	**100**	**25**	**75**
75	**50**	**0**	**50**	**25**	**0**
76	**75**	**0**	**75**	**0**	**0**
77	**75**	**25**	**75**	**50**	**25**
78	**100**	**25**	**75**	**50**	**50**
79	**75**	**0**	**75**	**25**	**25**
80	**75**	**50**	**100**	**50**	**50**
81	**100**	**50**	**100**	**50**	**50**
82	**100**	**75**	**100**	**25**	**50**
83	**75**	**0**	**50**	**25**	**25**
84	**75**	**0**	**25**	**0**	**0**
85	**100**	**100**	**100**	**25**	**50**
86	**100**	**50**	**75**	**50**	**50**
87	**75**	**50**	**75**	**50**	**50**
88	**75**	**0**	**75**	**25**	**50**
89	**75**	**25**	**50**	**25**	**25**
90	**50**	**0**	**50**	**25**	**0**

APPENDIX E
DISTRIDUTION OF STUDENTS SCORES IN THE VARIOUS TASKS IN TEST FOUR

Serial number	Observation (100)	Classification (100)	Habitat (100)	Drawing (100)	Adaptation (100)
1	50	0	50	50	25
2	50	0	75	50	50
3	25	0	50	50	0
4	0	0	50	25	0
5	50	0	50	50	0
6	50	0	75	50	0
7	50	25	75	50	25
8	50	25	75	50	0
9	50	50	100	50	0
10	50	25	75	50	0
11	25	0	50	25	0
12	50	25	75	75	0
13	50	25	100	50	25
14	50	0	75	75	0
15	75	50	100	50	0
16	50	50	75	50	0
17	75	25	100	50	25
18	75	25	100	75	0
19	50	25	75	75	0
20	50	25	100	75	0
21	50	0	100	50	0
22	50	0	75	75	0
23	50	0	75	50	0
24	25	0	75	75	0
25	50	0	75	50	0
26	25	0	50	25	0
27	0	0	25	25	0
28	25	0	50	0	0
29	25	0	0	0	0
30	0	0	50	0	0
31	50	25	50	25	25
32	50	25	50	0	0
33	50	25	75	0	0
34	50	0	50	0	0
35	50	25	50	25	25
36	25	0	50	0	0
37	50	0	50	25	25
38	25	0	50	0	0
39	50	25	50	25	25
40	25	0	50	0	0
41	25	0	50	0	0
42	0	0	25	50	0
43	25	0	50	50	0

44	**50**	**25**	**75**	**75**	**0**
45	**25**	**0**	**50**	**25**	**0**
46	**25**	**0**	**75**	**25**	**0**
47	**50**	**25**	**50**	**50**	**25**
48	**75**	**0**	**100**	**50**	**25**
49	**25**	**0**	**75**	**25**	**0**
50	**0**	**0**	**50**	**25**	**0**
51	**50**	**25**	**75**	**25**	**0**
52	**25**	**0**	**75**	**25**	**25**
53	**25**	**0**	**50**	**0**	**0**
54	**75**	**50**	**75**	**50**	**0**
55	**50**	**0**	**75**	**50**	**25**
56	**50**	**25**	**75**	**50**	**0**
57	**0**	**0**	**50**	**25**	**0**
58	**0**	**0**	**75**	**0**	**0**
59	**75**	**25**	**75**	**50**	**0**
60	**25**	**0**	**75**	**25**	**0**
61	**75**	**0**	**50**	**50**	**0**
62	**25**	**25**	**50**	**25**	**0**
63	**50**	**25**	**50**	**25**	**0**
64	**50**	**0**	**50**	**25**	**0**
65	**0**	**0**	**50**	**25**	**0**
66	**0**	**0**	**50**	**0**	**0**
67	**25**	**0**	**50**	**25**	**0**
68	**50**	**0**	**75**	**50**	**0**
69	**50**	**0**	**75**	**50**	**0**
70	**50**	**50**	**75**	**50**	**25**
71	**0**	**0**	**50**	**25**	**0**
72	**50**	**0**	**75**	**50**	**0**
73	**0**	**0**	**50**	**0**	**0**
74	**25**	**0**	**50**	**50**	**0**
75	**50**	**0**	**50**	**0**	**0**
76	**50**	**0**	**25**	**0**	**0**
77	**50**	**0**	**75**	**50**	**0**
78	**75**	**25**	**75**	**25**	**0**
79	**50**	**0**	**75**	**0**	**50**
80	**50**	**25**	**75**	**25**	**50**
81	**50**	**50**	**75**	**50**	**50**
82	**50**	**25**	**75**	**50**	**50**
83	**50**	**0**	**50**	**25**	**0**
84	**0**	**0**	**50**	**0**	**0**
85	**25**	**25**	**50**	**25**	**0**
86	**50**	**25**	**75**	**50**	**25**
87	**50**	**25**	**75**	**25**	**25**
88	**75**	**0**	**50**	**50**	**0**
89	**25**	**0**	**50**	**50**	**0**
90	**50**	**0**	**25**	**0**	**0**

APPENDIX F

TESTS USED IN THE PILOT STUDY

UNIVERSITY OF CAPE COAST

DEPARTMENT OF SCIENCE AND TECHNOLOGY EDUCATION

BIOLOGY PRACTICAL PERFORMANCE ASSESSMENT TEST

TEST ONE TIME:30MINS

SERIAL NUMBER _____ SEX: MALE/FEMALE AGE _____

QUESTIONS

Study carefully the following specimens and answer the questions that follow

1. Give the classes of each of specimen**A**,**C,D** and **E** (4marks)

SPECIMEN	**CLASS**

2. State **four (4)** observable features of specimen**A**(4marks)

_____

_____

_____

_____

3. Name **one (1)** possible habitat of each of specimen **A, B,D** and **E** (4marks)

SPECIMEN	**HABITAT**

4. Make a drawing **8-10cm** long of specimen **B** and label fully (4marks)

5. State any four (4) features that adapt specimen **C** to its habitat (4marks)
   _____
   _____
   _____
   _____
   _____
   _____

APPENDIX F CONTINUED

TEST USED IN THE PILOT STUDY

UNIVERSITY OF CAPE COAST

DEPARTMENT OF SCIENCE AND TECHNOLOGY EDUCATION

BIOLOGY PRACTICAL PERFORMANCE ASSESSMENT TEST

TEST TWO TIME:30MINS

SERIAL NUMBER _____ SEX: MALE/FEMALE AGE _____

QUESTIONS

Study carefully the specimens provided and use it to answer the questions that follow

1. Name the classes of plants into which specimen **A**, **B**, **C**and **D** belong (4marks)

SPECIMEN	**CLASS**

2. State any four **(4)** observable features of specimen **A** (4marks)

_____
_____
_____
_____
_____
_____
_____
_____
_____

3. Name **one (1)** habitat where each of specimen of **A**, **B**, **C** and **D** can be found (4marks)

SPECIMEN	**HABITAT**

4. Make a drawing **8-10cm** long of the leaf of specimen **C** (4marks)

5. State any **four (4)** features of biological importance that enable specimen **E** to carry out its function (4marks)

APPENDIX F CONTINUED

TEST USED IN THE PILOT STUDY

UNIVERSITY OF CAPE COAST

DEPARTMENT OF SCIENCE AND TECHNOLOGY EDUCATION

BIOLOGY PRACTICAL PERFORMANCE ASSESSMENT TEST

TEST THREE TIME: 30MINS

SERIAL NUMBER _____ SEX: MALE/FEMALE AGE _____

QUESTIONS

1. Give the phylum/division and classes of each of specimen **A**, **C**, **D** and **E** (4marks)

SPECIMEN	**PHYLUM/DIVISION**	**CLASS**

2. State **four (4)** observable features of specimen **D** (4marks)

_____
_____
_____
_____
_____

3. Name the habitats of specimen **A,B**, **D** and **E** (4marks)

SPECIMEN	**HABITAT**

4. Make a drawing 8-10cm long of dorsal view of specimen **E** and label fully (4marks)

5. State **four (4)** adaptive features of specimen **A** that enable it to survive in its habitat (4marks)

_____
_____
_____
_____
_____

APPENDIX F CONTINUED
TEST USED IN THE PILOT STUDY

UNIVERSITY OF CAPE COAST

DEPARTMENT OF SCINECE AND TECHNOLOGY EDUCATION

BIOLOGY PRACTICAL PERFORMANCE ASSESSMENT TEST

TEST FOUR TIME: 30MINS

SERIAL NUMBER _____ SEX: MALE/FEMALE AGE _____

QUESTIONS

Study carefully the following specimen and answer the questions that follow

1. Name the classes of fruits into which specimen **B, C**, **D** and **E** belong to (4marks)

SPECIMEN	**CLASS**

2. State any **four (4)** observable features of specimen **C** (4marks)

_____
_____
_____
_____
_____
_____
_____
_____

3. Name one (1) possible habitat where specimen **B, C, D** and **E** can be found (4marks)

SPECIMEN	**HABITAT**

4. Make a drawing **8-10cm** long of specimen **D** and label fully (4marks)

5. Give **four (4)**adaptive features of specimen **A**that enable it to perform its function (4marks)

_____
_____
_____
_____
_____
_____
_____

APPENDIX G

MARKING SCHEME USED IN THE PILOT TESTING

UNIVERSITY OF CAPE COAST

DEPARTMENT OF SCIENCE AND TECHNOLOGY EDUCATION

MARKING SCHEME FOR TEST ONE

LIST OF SPECIMEN

A ---------- Adult Grasshopper **D ---------- Agama Lizard**

B ---------- Grain Weevil **E ----------Earthworm**

C ----------Bony fish/ Tilapia

1. CLASSES OF SPECIMEN

SPECIMEN	**CLASS**
A	Insecta
C	Osteichthyes
D	Reptilia
E	Oligochaeta

Any 4 x 1 = 4marks **Note: correct spelling to score**

2. OBSERVABLE FEATURES OF SPECIMEN

Presence of antenna
Presence of enlarged hind limbs/ Presence of jointed legs
Presence of claspers
Presence of triangular head
Presence of greenish or light brown body colour
Presence of spiracles
Presence of membranous hind wings/forewings
Presence of compound eyes
Any 4 x 1 = 4marks

3. HABITAT OF SPECIMEN

SPECIMEN	**HABITAT**
A	Grassland, Fields, Vegetation
B	Stored grains eg. Maize, millet, guinea corn
D	Around uncompleted houses, packed blocks, around trees
E	In the soil

4. A **WELL LABELLED DIAGRAM 8-10CM LONG OF SPECIMEN B**

Title = ½ mark, 4 correct labeling = 2marks, correct size = ½ mark, magnification = ½ mark, clarity of lines = ½ mark
Total = 4marks

5. FEATURES OF ADAPTATION OF SPECIMEN C

Presence of lateral line for detecting vibration
Presence of fins for movement
Presence of streamlined body for easy movement in water
Presence of lidless eyes for vision
Presence of nostrils for smelling food in water
Presence of operculum for covering gills

Any 4 x 1 = 4marks

QUESTION TOTAL = 20MARKS

APPENDIX G CONTINUED
MARKING SCHEME USED IN THE PILOT STUDY

UNIVERSITY OF CAPE COAST

DEPARTMENT OF SCIENCE AND TECHNOLOGY EDUCATION
MARKING SCHEME FOR TEST TWO

LIST OF SPECIMEN

A ---------- Twig of mango
B ---------- Twig of Ixora
C ---------- Water Lettuce
D ---------- Euphorbia plant
E ---------- Crotalaria flower

1. CLASSIFICATION OF SPECIMEN

SPECIMEN	**CLASS**
A	Dicotyledonae
B	Monocotyledonae
C	Monocotyledonae
D	Dicotyledonae

Any 4 x 1 = 4marks **Note: Correct spelling to score**

2. OBSERVABLE FEATURES OF SPECIMEN D

Presence of long internodes
Presence of brightly coloured flowers
Presence of thorns on stem
Presence of green broad leaves
Presence of hard stem
Presence of long leaf stalk
Any 4 x 1 = 4marks

3. HABITAT OF SPECIMEN

SPECIMEN	**HABITAT**
A	Forest, Gardens, Farms
B	Damp soil, around houses
C	Stagnant waters, lakes rivers, lagoons, pond, (aquatic)
D D	Damp soil, Forest Damp soil, Forest

Any 4 x 1 = 4marks

4. A WELL LABELLED DIAGRAM OF SPECIMEN A LEAF OF SPECIMEN A

Title = ½ mark, 4 correct labelling = 2marks, magnification = ½ mark, size of diagram = ½ mark, Clarity of lines = ½ mark Total = 4marks

5. ADAPTIVE FEATURES OF SPECIMEN E

Presence of nectaries which secret nectar for attracting insect pollinators
Presence of brightly coloured petals for attracting insect pollinators
Presence of large and conspicuous petals for easy detection by pollinators
Presence of sweet scent which attract pollinators
Presence of honey guide which detect pollinators to nectary gland
Any 4 x 1 = 4marks

QUESTION TOTAL 20MARKS

APPENDIX G CONTINUED
FINAL MARKING SCHEME FOR THE PILOT STUDY
UNIVERSITY OF CAPE COAST
DEPARTMENT OF SCIENCE AND TECHNOLOGY EDUCATION
MARKING SCHEME FOR TEST THREE

LIST OF SPECIMEN

A ----------Slide of Hydra **D ---------- Young Toad**
B ----------Fern **E ---------- Adult Cockroach**
C ---------- Moss plant

1. CLASSIFICATION OF SPECIMEN

SPECIMEN	**DIVISION/PHYLUM**	**CLASS**
A	Cnidaria	Hydrozoa
C	Bryophyta	Musci
D	Chordata	Amphibia
E	Arthropoda	Insecta

Any 8 x ½ = 4marks **Note: Correct Spelling to score**

2. OBSERVABLE FEATURES OF SPECIMEN D

Presence of moist and loose warty skin
Presence of streamlined body
Presence of two large prominent eyes
Presence of a pair of nostril
Presence of nictating membrane
Presence of poison gland in the skin
Presence of wide mouth
Any 4 x 1 = 4marks

3. HABITAT OF SPECIMEN

SPECIMEN	**HABITAT**
A	Sea, Ocean, aquatic
B	Tree trunk, moist soil, forest floor, footpath
D	Under stoned, under tree trunk, in the ground
E	Septic tanks, Cupboard, Crevices

Any 4 x 1 = 4marks

4. A WELL LABELLD DIAGRAM SHOWING THE DORSAL VIEW OF SPECIMEN E

Title = ½ mark, 4 correct labeling = 2marks, magnification = ½ mark, size of diagram = ½ mark, clarity of lines = ½ mark. Total = 4marks

5. ADAPTIVE FEATURES OF SPECIMEN A

Presence of tentacles for catching prey
Presence of enteron for digestion
Presence of basal disc for firm attachment to substratum
Presence of gonads for reproduction
Presence of mouth for ingestion and egestion
Presence of cnidoblast around the mouth for defence **Any 4 x 1 = 4marks**

QUESTION TOTAL 20MARKS

APPENDIX G CONTINUED
MARKING SCHEME USED FOR THE PILOT STUDY
UNIVERSITY OF CAPE COAST
DEPARTMENT OF SCIENCE AND TECHNOLOGY EDUCATION
MARKING SCHEME FOR TEST FOUR

LIST OF SPECIMEN

A ---------- Small intestine of a goat cut open
B ---------- Pineapple
C ---------- Mango
D ---------- Tomato fruit
E ---------- Orange fruit

1. CLASSIFICATION OF SPECIMEN

SPECIMEN	**CLASS OF FRUIT**
B	False fruit, multiple fruit
C	Drupe
D	Berry
E	Berry/ Hesperidium

Any 4 x 1 = 4marks **Note: correct spelling to score**

2. OBSERVABLE FEATURES OF SPECIMEN C

Presence of hard or woody endocarp
Presence of fleshy and succulent mesocarp
Presence of one large fruit
Presence of kidney or bean shaped
Presence of style remains
Presence of stalk remains

Any 4 x 1 = 4marks

3. HABITAT OF SPECIMEN

SPECIMEN	**HABITAT**
B	Farms, Gardens, Terrestrial
C	Forest, Farms, Around buildings
D	Farms, Gardens, Terrestrial
E	Forest, Farms, Terrestrial

Any 4 x 1 = 4marks

4. A WELL LABELLED DIAGRAM OF SPECIMEN D

Title = ½ mark, 4 correct labelling = 2marks, magnification ½ mark, clarity of lines ½ mark, size of drawing ½ mark Total = 4marks

5. ADAPTIVE FEATURES OF SPECIMEN A

Presence of villi on inner surface for absorption of digested food
Presence of numerous villi which increase the surface area for maximum absorption
Presence of rich supply of blood vessel for maximum absorption of digested food
Presence of thin walls for easy diffusion of end product of digestion
Presence of great length to provide a large surface area for maximum absorption
Any 4 x 1 = 4marks
QUESTION TOTAL: 20MARKS

APPENDIX H

TESTS USED IN THE MAIN STUDY

UNIVERSITY OF CAPE COAST

DEPARTMENT OF SCIENCE AND TECHNOLOGY EDUCATION

BIOLOGY PRACTICAL PERFORMANCE ASSESSMENT TEST

TEST ONE TIME: 30MINS

SERIAL NUMBER _____ SEX: MALE/FEMALE AGE _____

QUESTIONS

Study carefully the following specimens and answer the questions that follow

6. Give the classes of each of specimen**A**,**C,D** and **E** (4marks)

SPECIMEN	**CLASS**

7. State **four (4)** observable features of specimen**A**(4marks)

_____
_____
_____
_____
_____
_____
_____

8. Name **one (1)** possible habitat of each of specimen **A, B,D** and **E** (4marks)

SPECIMEN	**HABITAT**

9. Make a drawing **8-10cm** long of specimen **B** and label fully (4marks)

10. State any four (4) features that adapt specimen **C** to its habitat (4marks)

_____
_____
_____
_____
_____
_____
_____
_____

APPENDIX H CONTINUED
TEST USED IN THE MAIN STUDY

UNIVERSITY OF CAPE COAST

DEPARTMENT OF SCIENCE AND TECHNOLOGY EDUCATION

BIOLOGY PRACTICAL PERFORMANCE ASSESSMENT TEST

TEST TWO TIME:30MINS

SERIAL NUMBER _____ SEX: MALE/FEMALE AGE _____

QUESTIONS

Study carefully the specimens provided and use it to answer the questions that follow

6. Name the classes of plants into which specimen **A**, **B**, **C**and **D** belong (4marks)

SPECIMEN	**CLASS**

7. State any four **(4)** observable features of specimen **A** (4marks)

_____
_____
_____
_____
_____
_____
_____
_____
_____

8. Name **one (1)** habitat where each of specimen of **A**, **B**, **C** and **D** can be found (4marks)

SPECIMEN	**HABITAT**

9. Make a drawing **8-10cm** long of the leaf of specimen **C** (4marks)

10. State any **four (4)** features of biological importance that enable specimen **E** to carry out its function (4marks)

_____

_____

_____

_____

_____

_____

APPENDIX H CONTINUED

TEST USED IN THE MAIN STUDY

UNIVERSITY OF CAPE COAST

DEPARTMENT OF SCIENCE AND TECHNOLOGY EDUCATION

BIOLOGY PRACTICAL PERFORMANCE ASSESSMENT TEST

TEST THREE TIME: 30MINS

SERIAL NUMBER _____ SEX: MALE/FEMALE AGE _____

QUESTIONS

6. Give the phylum/division and classes of each of specimen **A**, **C**, **D** and **E** (4marks)

SPECIMEN	**PHYLUM/DIVISION**	**CLASS**

7. State **four (4)** observable features of specimen **D** (4marks)

_____
_____
_____
_____

8. Name the habitats of specimen **A,B**, **D** and **E** (4marks)

SPECIMEN	**HABITAT**

9. Make a drawing 8-10cm long of dorsal view of specimen **E** and label fully (4marks)

10. State **four (4)** adaptive features of specimen **A** that enable it to survive in its habitat (4marks)

_____
_____
_____
_____
_____
_____
_____

APPENDIX H CONTINUED

TEST USED IN THE MAIN STUDY

UNIVERSITY OF CAPE COAST

DEPARTMENT OF SCINECE AND TECHNOLOGY EDUCATION

BIOLOGY PRACTICAL PERFORMANCE ASSESSMENT TEST

TEST FOUR TIME: 30MINS

SERIAL NUMBER _____SEX: MALE/FEMALE AGE _____

QUESTIONS

Study carefully the following specimen and answer the questions that follow

6. Name the classes of fruits into which specimen **B, C**, **D** and **E** belong to (4marks)

SPECIMEN	CLASS

7. State any **four (4)** observable features of specimen **C** (4marks)

_____
_____
_____
_____
_____
_____
_____
_____

8. Name one (1) possible habitat where specimen **B, C, D** and **E** can be found (4marks)

SPECIMEN	**HABITAT**

9. Make a drawing **8-10cm** long of specimen **D** and label fully (4marks)

10. Give **four (4)**adaptive features of specimen **A**that enable it to perform its function (4marks)

_____
_____
_____
_____
_____
_____

APPENDIX I
FINAL MARKING SCHEME FOR THE STUDY

UNIVERSITY OF CAPE COAST

DEPARTMENT OF SCIENCE AND TECHNOLOGY EDUCATION
FINAL MARKING SCHEM FOR TEST ONE

LIST OF SPECIMENS

A ---------- Domestic fowl **D -------- Agama Lizard**
B ---------- Rabbit **E -------Young Toad**
C ----------Bony fish/ Tilapia

1. CLASSIFICATION OF SPECIMEN

SPECIMEN	**CLASS**
A	Aves
C	Osteichthyes
D	Reptilia
E	Amphibia

2. OBSERVABLE FEATURES OF SPECIMEN B

Presence of feathers
Presence of scales on legs
Presence of beak
Presence of wings
Presence of comb
Presence of wattles
Presence of eyes
Presence of claw digit

Any 4 x 1 = 4marks

3. **HABITAT OF SPECIMEN**

SPECIMEN	**HABITAT**
A	Homes, Poultry farms
B	Homes, Rabittary
D	On walls, on trees, around uncompleted buildings
E	**Under stones, In packed blocks, in moist places, under tree trunks**

Any 4 x 1 = 4marks

4. A WELL LABELLED DIAGRAM 8-10CM LONG OF SPECIMEN B

Title ½ mark, 4 correct labeling = 2marks, correct size ½ mark, magnification ½ marks, clarity of lines = ½ mark Total = 4marks

5. **FEATURES OF ADAPTATION OF SPECIMEN C**

Presence of lateral line for detecting vibration
Presence of fins for movement
Presence of streamlined body for easy movement in water
Presence of lidless eyes for vision
Presence of nostrils for smelling food in water
Presence of operculum for covering gills

Any 4 x 1 = 4marks

QUESTION TOTAL = 20MARKS

APPENDIX I CONTINUED

FINAL MARKING SCHEME FOR THE STUDY

UNIVERSITY OF CAPE COAST

DEPARTMENT OF SCIENCE AND TECHNOLOGY EDUCATION

FINAL MARKING SCHEME FOR TEST TWO

LIST OF SPECIMEN

A ---------- Twig of mango **D ---------- Euphorbia plant**

B ----------Twig of Ixora **E ---------- Crotalaria flower**

C ---------- Water Lettuce

6. CLASSIFICATION OF SPECIMEN

SPECIMEN	**CLASS**
A	Dicotyledonae
B	Monocotyledonae
C	Monocotyledonae
D	Dicotyledonae

Any 4 x 1 = 4marks **Note: Correct spelling to score**

7. OBSERVABLE FEATURES OF SPECIMEN D

Presence of long internodes

Presence of brightly coloured flowers

Presence of thorns on stem

Presence of green broad leaves

Presence of hard stem

Presence of long leaf stalk

Any 4 x 1 = 4marks

8. HABITAT OF SPECIMEN

SPECIMEN	HABITAT
A	Forest, Gardens, Farms
B	Damp soil, around houses
C	Stagnant waters, lakes rivers, lagoons, pond, (aquatic)
D D	Damp soil, Forest Damp soil, Forest

Any 4 x 1 = 4marks

9. A WELL LABELLED DIAGRAM OF SPECIMEN A LEAF OF SPECIMEN A

Title = ½ mark, 4 correct labelling = 2marks, magnification = ½ mark, size of diagram = ½ mark, Clarity of lines = ½ mark Total = 4marks

10. ADAPTIVE FEATURES OF SPECIMEN E

Presence of nectaries which secret nectar for attracting insect pollinators

Presence of brightly coloured petals for attracting insect pollinators

Presence of large and conspicuous petals for easy detection by pollinators

Presence of sweet scent which attract pollinators

Presence of honey guide which detect pollinators to nectary gland

Any 4 x1 = 4marks

QUESTION TOTAL 20MARKS

APPENDIX I CONTINUED
FINAL MARKING SCHEME FOR THE STUDY
UNIVERSITY OF CAPE COAST
DEPARTMENT OF SCIENCE AND TECHNOLOGY EDUCATION
FINAL MARKING SCHEME FOR TEST THREE

LIST OF SPECIMEN

A ----------Adult Grasshopper **D ---------- Grain Weevil**

B ----------Fern **E ----------Adult Cockroach**

C ----------Moss plant

1. CLASSIFICATION OF SPECIMEN

SPECIMEN	**DIVISION/PHYLUM**	**CLASS**
A	Arthropoda	Hydrozoa
C	Filicinophyta	Pteropsida
D	Arthropoda	Insecta
E	Arthropoda	Insecta

Any 8 x ½ = 4marks **Note: Correct Spelling to score**

2. OBSERVABLE FEATURES OF SPECIMEN D

Presence of wings

Presence of antenna

Presence of two rostrum

Presence of jointed legs

Presence of eyes

Presence of cape

Smaller in size

Any 4 x 1 =4marks

3. HABITAT OF SPECIMEN

SPECIMEN	HABITAT
A	Farms, Forest, Fields, Leafy vegetation
B	Moist soil, footpath Tree trunk, moist soil, forest floor, footpath
D	In stored grains eg. Maize, millet, beans
E	Septic tanks, Cupboard, Crevices

Any 4 x 1 = 4marks

4. A WELL LABELLD DIAGRAM SHOWING THE DORSAL VIEW OF SPECIMEN E

Title = ½ mark, 4 correct labeling = 2marks, magnification = ½ mark, size of diagram = ½ mark, clarity of lines = ½ mark. Total = 4marks

5. ADAPTIVE FEATURES OF SPECIMEN A

Presence of tentacles for catching prey

Presence of enteron for digestion

Presence of basal disc for firm attachment to substratum

Presence of gonads for reproduction

Presence of mouth for ingestion and egestion

Presence of cnidoblast around the mouth for defence

Any 4 x 1 = 4marks

QUESTION TOTAL 20MARKS

APPENDIX I CONTINUED
FINAL MARKING SCHEME FOR THE STUDY

UNIVERSITY OF CAPE COAST
DEPARTMENT OF SCIENCE AND TECHNOLOGY EDUCATION

FINAL MARKING SCHEME FOR TEST FOUR

LIST OF SPECIMEN

A ---------- Small intestine of a goat cut open

B ---------- Pineapple

C ---------- Mango

D ---------- Tomato fruit

E ---------- Orange fruit

1. CLASSIFICATION OF SPECIMEN

SPECIMEN	**CLASS OF FRUIT**
B	False fruit, multiple fruit
C	Drupe
D	Berry
E	Berry/ Hesperidium

Any 4 x 1 = 4marks Note: correct spelling to score

2. OBSERVABLE FEATURES OF SPECIMEN C

Presence of hard or woody endocarp

Presence of fleshy and succulent mesocarp

Presence of one large fruit

Presence of kidney or bean shaped

Presence of style remains

Presence of stalk remains

Any 4 x 1 = 4marks

3. HABITAT OF SPECIMEN

SPECIMEN	**HABITAT**
B	Farms, Gardens, Terrestrial
C	Forest, Farms, Around buildings
D	Farms, Gardens, Terrestrial
E	Forest, Farms, Terrestrial

Any 4 x 1 = 4marks

4. A WELL LABELLED DIAGRAM OF SPECIMEN D

Title = ½ mark, 4 correct labelling = 2marks, magnification ½ mark, clarity of lines ½ mark, size of drawing ½ mark Total = 4marks

5. ADAPTIVE FEATURES OF SPECIMEN A

Presence of villi on inner surface for absorption of digested food

Presence of numerous villi which increase the surface area for maximum absorption

Presence of rich supply of blood vessel for maximum absorption of digested food

Presence of thin walls for easy diffusion of end product of digestion

Presence of great length to provide a large surface area for maximum absorption

Any 4 x 1 = 4marks

QUESTION TOTAL: 20MARKS