UNIVERSITY OF EDUCATION, WINNEBA

# THE IMPACT OF PRACTICAL ACTIVITIES ON TEACHING AND LEARNING OF BIOLOGY AT BIRIM CENTRAL MUNICIPALITY

FREDA NYARKO

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**A Dissertation in the Department of SCIENCE EDUCATION, Faculty of SCIENCE EDUCATION, submitted to the School of Graduate Studies, University of Education, Winneba in partial fulfillment of the requirements for award of the MASTER OF SCIENCE IN EDUCATION degree**

**DECEMBER, 2016**

# DECLARATION

**Student's Declaration**

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

Signature:……………………………

Date:…………………………………

**Supervisor's Declaration**

I certify that the preparation and presentation of this project work was supervised by me in accordance with the guidelines for supervision of project work laid down by the University of Education, Winneba.

Supervisor's Name: **PROF. YAW AMEYAW**

Signature:……………………………

Date:…………………………………

# DEDICATION

I count it a real joy and a privilege to dedicate this project work to Dr. Micheal Agyekum Addo, Mr. Emmanuel Mensah my husband, my father, Mr. J. D. Nyarko and my children, who have played major roles in my life.

# ACKNOWLEDGEMENTS

I thank God for how far He has brought me. I owe the writing of this project work to the wisdom, knowledge and the understanding he has granted me. Glory and honor be unto His name. My sincere appreciation goes to my supervisor, Prof. Yaw Ameyaw in the University of Education, Winneba, for his time, tolerance, patience, guidance and advice in writing of this project work.

I am also grateful to my family for their support and encouragement in the writing of this project work. I thank you very much. Special thanks also go to my husband for encouraging me to do this program. Thank you very much for your various contributions and prayers towards my education.

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# ABSTRACT

The study investigated the impact of activities on teaching and learning of Biology at the Birim Central Municipality in the Eastern Region of Ghana. The sample population was made up of one hundred students and twenty five (25) biology teachers from the five (5) selected Senior High Schools. Data collected were analysed using SPSS version 20.0 and analysed data were converted into frequency counts and percentages. Findings of the study revealed that, biology teachers in the municipality do not have academic qualification and/or certificate pertaining to biology. Also, teacher-centered approach was used in teaching biology practical lesson. Again, though some SHS in the Birim Central Municipality have science laboratories and equipment, they cannot function as expected. Moreover, biology teachers were unable to use practical activities in their lessons as a result of small size of the laboratory, inadequate biology apparatus and large class size. Similarly, teachers should be more innovative in preparing teaching and learning materials to help them modify their teaching strategies in order to embrace the benefits of interactive teaching, including longer and increased students' conceptual understanding.

# CHAPTER ONE

# INTRODUCTION

## 1.0 Overview

This chapter dealt with the background to the study, statement of the problem, purpose, research objectives and research questions. The significance of the study, delimitations, limitations, definition of terms and abbreviations and organization of the study.

## 1.1 Background to the Study

Science can be related to the lives of all students, and it is essential to preparing students for the transition to adulthood and for membership in an increasingly technological workforce (Fradd & Lee, 1995; Gurganus, Janas & Schmitt, 1995; Patton, 1995). Science education can help students learn about the physical environments in which they live and develop a multicultural worldview of scientific phenomena. For many students, particularly those who are learning English, science activities can serve as a vehicle for developing language skills and social behaviors (Fathman, Quinn & Kessler, 1992).

Thus, science is a great enterprise which nations depend on, in-order to advance technologically. Science therefore, is receiving much emphasis in its education because of its significance and relevance to life and society. Biology as a branch of science and the prerequisite subject for many fields of learning contributes immensely to the technological growth of every nation. This includes medicine, forestry, agriculture, biotechnology and nursing. The study of biology in Senior High Schools (SHS) can equip students with useful concepts, principles and theories that would enable them face the challenges before and after graduation (Fathman, Quinn & Kessler, 1992). But, it has been perceived that most SHS students have difficulties in the study of biology in Ghana.

Students' difficulties in learning biology as a high school subject have been studied by various researchers across the world (Johnstone & Mahmoud, 1980; Finley, Steward, & Yaroch, 1982; Tolman, 1982; Anderson, Sheldon & Dubay, 1990; Seymour & Longdon, 1991; Lazarowitz & Penso, 1992; Bahar, Johnstone & Hansell, 1999). Many concepts or topics in biology, including water transport in plants, protein synthesis, respiration and photosynthesis, gaseous exchange, energy, cells, mitosis and meiosis, organs, physiological processes, hormonal regulation, oxygen transport, genetics, Mendelian genetics, genetic engineering, and the central nervous system can be perceived as difficult to learn by some SHS students (Tekkaya, Özkan & Sungur, 2001). However, the use of practical activities could help students have a better understanding of such topics. Tekkaya *et al.,* (2001) also found that hormones, genes and chromosomes, mitosis and meiosis, the nervous system, and mendelian genetics were considered difficult concepts by SHS students. Experiencing difficulties in so many topics in biology negatively affects students' motivation and achievement (Özcan, 2003).

Furthermore, there are many reasons why students have difficulties in learning biological concepts (Lazarowitz & Penso, 1992; Tekkaya *et al.,* 2001; Çimer, 2004; Zeidan, 2010). The nature of science itself and its teaching methods are among the reasons for the difficulties in learning science, while according to Lazarowitz and Penso (1992), the biological level of organization and the abstract level of the concepts make the learning biology difficult. Overloaded biology curricula, the abstract and interdisciplinary nature of biological concepts, and difficulties with the textbooks are other factors preventing students from learning biology effectively (Chiapetta & Fillman, 1998; Tekkaya *et al.,* 2001).

However, all these studies were conducted outside Ghana and therefore lack the necessary evidence on the impact of practical activities on the academic performance of biology students in the Ghana setting; hence, the need for this study to be conducted.

## 1.2 Statement of the Problem

My experience in teaching coupled with student's academic information revealed that students offering Biology perform poorly in their final examination. The schools within the District also lack adequate science materials for practical lessons, teachers practical handbooks, laboratories and qualified laboratory assistants to help in practical lessons. Apart from the above problems, time allocated for practical lessons is not adequate and this hinders the organization of practical lessons and a critical look at the content of the Biology Syllabus shows that it is very loaded (Asiedu & Amoako, 2010).

They have difficulties understanding what they are taught in the Biology class, where teachers only rush through the syllabus with the aim of completing it but only end up achieving just a little learning outcome (Ntow, 2007). The tutors think that, by putting in much interms of theory, much would be achieved but it is never so. They put in much theory and yield a little in terms of knowledge acquisition (Ntow, 2007) because there is little or no practical work.

## 1.3 Purpose of the Study

The purpose of the study was to find out how to impact practical activities on teaching and learning of Biology students in selected Senior High Schools in the Birim Central Municipality.

## 1.4 Objectives of the Study

The study sought to:

1. identify kinds of teaching methods used by biology teachers during teaching in the Birim Central Municipality.
2. examine the state of facilities (science laboratory, equipment etc.) available to biology teachers for teaching in the Birim Central Municipality.
3. investigate the effects of practical activities on the academic performance of biology students in the Birim Central Municipality.
4. identify challenges faced by Biology teachers in using practical activities in biology teaching and learning in the Birim Central Municipality.
5. suggest solution strategies to the challenges faced by biology teachers in using practical activities in teaching and learning biology.

## 1.5 Research Questions

The following research questions were formulated to guide the study:

1. What is the state of facilities (science laboratory, equipment etc.) available to biology teachers for teaching of biology in the Birim Central Municipality?
2. What effects do practical activities have on the academic performance of biology students in the Birim Central Municipality?
3. What challenges do biology teachers face in using practical activities during the teaching of biology in the Birim Central Municipality?

4. What strategies could help solve the challenges faced by biology teachers in using practical activities in biology teaching and learning?

## 1.6 Significance of the Study

It was expected that, findings from this study would provide science educators, science curriculum planners and government with detailed picture of science (biology) teaching and learning, and educational practices in SHS in Ghana and realistic, cost effective ways of improving the situation. This in turn would help in planning and formulating further policies for biology education in Ghana.

Additionally, findings from this study would throw light on the methods used by biology teachers in biology teaching and learning at the SHS level and to determine whether their methods are effective in improving the performance of students. Likewise, the study would create the awareness to school authorities, biology teachers and students in the Birim Central Municipality about the factors that hinder their academic performance in biology education.

Moreso, the findings would add to existing knowledge on solutions to learners' problems of not performing well in the practical examination paper. Similarly, biology teachers would benefit from this study by ascertaining whether or not their practical activities are adequate to improve upon the academic performance of biology students. Likewise, findings and recommendations of the study would help biology teachers reexamine their teaching methods and lesson delivery in the quest to maximize students learning outcomes.

Again, the findings would help in designing the science curriculum for teacher training courses in order to teach biology effectively at the SHS level; biology teachers must first experience practical-activity teaching methods in training, so that they can also impact such knowledge and skills when they come to the field of work. Notwithstanding the above, findings from this study would be used by other researchers as a baseline study for future studies in the area. Lastly, the findings of the study can provide insight in designing biology materials to be used in SHS in Ghana and beyond.

## 1.7 Delimitations

The delimited topics includes; teaching methods used by biology teachers, state of facilities (science laboratory, equipment etc.) available to biology teachers, effects of practical activities on the academic performance of biology students, challenges faced by biology teachers in using practical activities and strategies to help solve such challenges faced by biology teachers.

Again, the study focused on SHS 1 and 2 biology students. This was because they were better placed, they were focused as they had already chosen biology as a subject based on career.

Last but not least, private SHS were excluded from the study because they were under different management and resources they use were highly varied.

## 1.8 Limitations

The study was limited to only five (5) selected Senior High Schools at the Birim Central Municipality of the Eastern Region of Ghana. Also, because of the busy schedules of the teachers and the students, they were reluctant to complete the questionnaire in good time. The study was further limited to 20 students from each school making a total of 100 and five teachers from each school making a total of twenty five (25).

### 1.9 Definition of Terms and Abbreviations

**Practical Activity**: Practical activity is defined as the component of biology teaching and learning that focuses on investigating phenomenon through hands and minds inquiry. It is seen as hands-on, or minds-on practical learning interaction by learners (Stoffel, 2005). It does not only mean hands-on activity involving equipment, but also encompasses a range of other ways of working, including teacher demonstration, interaction between students and between students and teachers. It may involve individual activity such as measurement, observation and investigation. Thus, practical activity can take different forms from experiments to pencil and paper activity and may take place in the laboratory, classroom or elsewhere (Stoffels, 2005).

**Teachers' Perceptions of Practical Activity**: This refers to how teachers see and understand practical in the context of teaching and learning biology (Hornby, 2005).

**Meaningful learning:** This refers to the concept that the learned knowledge (let's say a fact) is fully understood by the individual and that the individual knows how that specific fact relates to other stored facts (in the brain) (Douglas & Jaquith, 2009).

**Student-centred learning**: this refers to an approach to education that focuses on the needs of the students, that is, putting students first. Thus, student-centred learning is focusing on the student's needs, abilities, interests, and learning styles with the teacher only as a facilitator of learning. This classroom teaching and learning method acknowledges student voice as central to the learning experience for every learner (Douglas & Jaquith, 2009).

**Active learning:** This is a technique where students do more than simply listen to a lecture; students discover process and apply information because the responsibility of learning is placed on the students themselves (Douglas & Jaquith, 2009).

**Teaching Strategy:** A complex educational behavior of a teacher in using methods, techniques, tools, discipline and communications in order to achieve set goals and /or objectives (Creswell, 1990).

**Methods:** Procedures, styles or ways in which a teacher selects to facilitate the teaching-learning process (Weeks, 1988).

**Teaching Laboratory:** Refers to a room which contains science equipment for teaching and learning of science related courses.

**Teaching Tools:** Equipment used in facilitating the teaching-learning process (Creswell, 1990).

**Technique:** A teaching method, skill, style or procedure which a teacher has selected to facilitate the teaching/learning process (Chonjo, Osaki, Possi & Mrutu, 1996).

**Perception:** A judgment or interpretive ability based on knowledge and insight gained through a teacher's senses, an observation or awareness of some condition, event or concept (Creswell, 1990).

**Teaching and Learning Materials:** These are instructional materials used to support students and teachers in the process of teaching and learning. They include text books, schemes of work, lesson plans and other related resources responsible in facilitating the teaching and learning process (Chonjo, Osaki, Possi & Mrutu, 1996).

**Performance:** Refers to the accomplishment of a given task measured against preset standards of accuracy, completeness, cost and speed. Education performance is deemed to be the fulfillment of an objective in a manner that ensures that the performer has attained the set goals in the given level of education. Performance in education is always accompanied by an academic certificate to show that the performer has successfully completed the grade or course and has attained the stated grades (Chonjo *et al.,* 1996).

**Use:** Utilizing and/or applying an appropriate process or tool to achieve a desired result (Chonjo, Osaki, Possi & Mrutu, 1996).

**SHS:** Senior High School.

**JHS:** Junior High School.

**CRDD:** Curriculum Research and Development Division

**FGN:** Federal Government of Nigeria.

**FME:** Federal Ministry of Education.

**NPE:** National Policy on Education.

**NRCS:** National Science Education Standards.

**MNE:** Ministry of National Education.

**NRC:** National Research Council.

**DOE:** Department of Education.

**NGO:** Non-governmental organization.

**GES:** Ghana Education Service.

### 1.10 Organization of the Study

This study has five chapters and chapter one dealt with the background to the study, statement of the problem, purpose and objectives of the study. It further dealt with the research questions, significance, delimitations, limitations, definition of terms and abbreviations and organization of the study. Chapter two dealt with review of literature related to the study.

Chapter three outlined the methodology (various approaches that were followed to gather data for the study and how the data was analyzed). It includes the justification for the research approach, research design, population, sample and sampling procedures, research instrument, procedure for data collection and the statistical tools used to analyze the data. Chapter four focused on data analysis and discussions of findings. Finally, chapter five focused on the findings, conclusions, and recommendations.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.0 Overview

This chapter reviews related literature on the impact of practical activities on the academic performance of biology students. The chapter focused on the following sub-topics:

1. Theoretical Framework of the Study,
2. Conceptual Framework of the Study,
3. Practical Activity/Inquiry in Science Education,
4. Teaching Methods in Science Education,
5. Effects of practical activities on the academic performance of students,
6. Challenges faced by science teachers in using practical activities,
7. Strategies used by science teachers to deal with such challenges and
8. Chapter summary

## 2.1 Theoretical Framework of the Study

Adopted theoretical framework for the study was the "ACTIONS" model in using practical activities and planning lessons that would enhance the performance of biology students in the Birim Central Municipality. This model was originally developed by Bates (1990) for making decisions about the use of technology and suggested factors to be considered when using the model so as to enhance effective teaching and learning. "ACTIONS" is an acronym for the description of a set of tasks central to the informed selection and use of practical activities in classroom teaching and learning. These tasks are;

A–Accessibility

C–Cost

T–Training

I–Interaction

O–Organization policy

N–Novelty

S–Speed

**i. A–Accessibility**

In this case the "A" stands for *accessibility* which deals with the accessibility of resources to the teachers or learner. The issue now is: How accessible is the laboratory and equipment to teachers and students for biology practical in the school? This first step is based on the premise that some factors such as administration and storage may interfere with how well biology students and teachers utilize facilities and equipment during practical activities.

**ii. C–Cost**

The "C" stands for *cost*, for science equipment. The question now is: Are resources (such as the laboratory and equipment for biology practical) expensive that the schools could not afford them? Cost is a key thing in deciding on the use of practical activities in the teaching and learning of biology at the SHS level. This can be overcome by proper management of both internal and external public by the school if the school's goal and guideline on teaching and learning process have to be realized meaningfully.

**iii. T–Training**

The "T" stands for *training/teaching* function. A pertinent question to ask is: Do biology teachers use practical activities in their teaching at the SHS level? Are biology teachers trained to use practical activities in their teaching? What are the requirements of biology teachers in using practical activities in their teaching? This can be overcome by in-servicing for biology teachers. This and many other questions are the focus of this study.

**iv. I–Interaction**

The "I" stands for *interaction*. Question: What kind of teacher-to-student interaction is built during the teaching and learning process? Is it teacher-student or student - student interaction in the use of practical activities during biology lessons? Are students and teachers able to interact effectively when using science equipment or at the laboratory? Or science equipment is kept in the principal's/headmaster's office?

**v. O–Organization Policy**

The "O" stands for *organization*. Organizational (school policy) changes would be required to facilitate the use of practical activities in the teaching and learning of biology? Do policies in the school assist or inhibit the use of science resources? Is there bureaucracy in the use of practical activities during biology lessons?

**vi. N–Novelty**

The "N" stands for *novelty*, meaning, how new are practical activities to biology teachers and students? How often do biology students experience practical activities? The issue of Novelty could be achieved in the school if the staff is involved in decision making on the purchase of new science equipment and resources for the school.

**vii. S–Speed**

The “S” stands for *speed*. This looks at how quickly and easily biology practical materials can be updated and changed in the school. How fast can biology teachers launch teaching using these practical activities?

In conclusion, the “ACTIONS” model was one sure strategy in the attempt to effectively integrate practical activities in the teaching and learning of SHS Biology in the Birim Central Municipality. Patel (1986) argues that the availability of the materials (resources) does not necessary guarantee the realization of stated lesson objectives. The materials should be presented in an orderly manner at the appropriate time and in conducive environment. Doing so poses a lot of challenges to both teachers and students which this study seeks to investigate and thus make recommendations on how to overcome these challenges.

## 2.2 Conceptual Framework

Studies have shown that instructional practices depend on what teachers bring to the classroom and that professional competence is a crucial factor in classroom and school practices (Campbell, McNamara & Gilroy, 2004; Kunter & Baumert, 2006). Teaching practices which are related to effective classroom teaching and learning and students’ learning outcomes have also been described and shown to have a positive impact on student achievement (Scheerens, 2009). These aforementioned practices can be said to be embedded in a specific instructional model carefully designed to impact on student learning.

This study was conceptualized to contribute to the improvement of the teaching and learning of SHS biology through the use of practical activities. Human learning is naturally an active mental and social process (Hung & Khine, 2006). Students must interact with their environment and manipulate objects so as to determine proper interpretations of phenomena. For teaching and learning to be meaningful, practical activities must be incorporated into the teaching and learning process which is geared towards the student's interests, abilities and readiness to become involved in the teaching and learning situations. Dale (1969) notes in his "cone of experience" that for learning to be meaningful, there must be interrelated learning experiences through the use of practical activities so as to make learning as interesting as possible. There must be connection between symbolic (words), observation of phenomena and participation that make up the foundation of learning. Bates (1990) calls this an informed selection and use of practical activities in classroom teaching as demonstrated by "ACTIONS".

Relevant strategy, practical activities and methods must be employed in order to achieve the intended objectives (Grabe & Grabe, 1998). Learners begin their learning of specific concepts with a broad base of direct experience in action. Gradually, they omit these specific, firsthand, concrete occurrences and impressions as they come to rely on iconic substitutes or pictorial representations. At both stages, the learners develop a summarizing idea or symbol. Dale (1969) illustrates these important ideas by indicating the broad base which directs experiences, provides for students learning and communication. It classifies various types of practical activities according to the relative degree of experiential concreteness that each can provide. The cone suggests the interrelated and interdependent nature of learning experiences and the use of practical activities; and hence makes mediated learning simple, enjoyable and stimulating for the learners. Hence, Bates "ACTIONS" model therefore becomes handy if this has to be realized.

The teacher observes the learners behavior and measures the success of the instructional process as the learners receive from practical activities (use of it) and reacting to them as well. This gives the teacher a clear feedback and helps in assessing the learning outcomes which is the new trend in modern teaching and learning (Newby, Stepich, Lehman & Russell, 2006). Patel (1986) notes that, effective use of practical activities should be guided by learning needs, quality of materials and possibility of combination of materials. The teacher should select practical activities that would accomplish the task of meeting the learning needs and helping learners to achieve the specific objectives constructed for specific content, hence the use of practical activities in teaching and learning in biology.

According to Grabe and Grabe (1998), an effective and meaningful teaching–learning process must provide for reflective practice. It should pave way for core educational activities through which students would acquire determined skills and a myriad of diversified learning opportunities as provided by the practical activities. Thus, it would be easy to design and plan a common activity and at the same time cater for individual differences of students (Hung & Khine, 2006). Teachers should be provided with a variety of practical activities as these are tools that facilitate effective teaching. In an individualized approach, the students are encouraged to undertake tasks from which it is possible to understand whether they reach the required level of performance related to a specific activity (task given). However, optimal use of practical activities is not possible in situations of unavailability, inadequacy, inaccessibility, cost and lack of knowledge to operate equipment among other reasons. As stipulated in the cone of learning experience, biology teachers at the SHS level should therefore refine the techniques for effective use of practical activities if maximum learning of biology is to be accomplished. The conceptual framework is summarized in Figure 1.

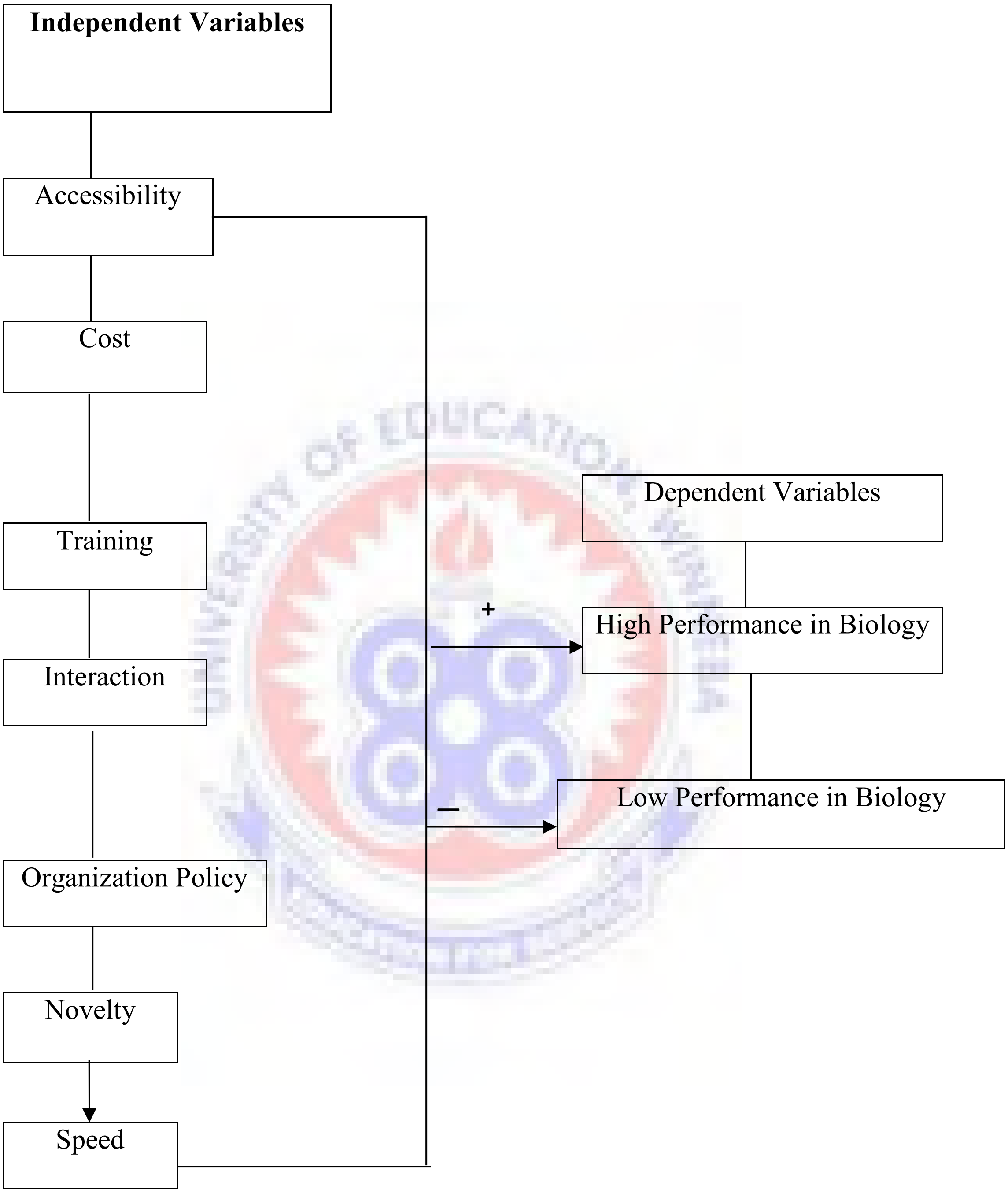


**Fig. 1: Illustration of conceptual framework of the study**

It is envisaged from Figure1 that, there were seven (7) independent variables based on the theoretical framework of the study. If these independent variables were effectively and efficiently managed in the school, there would be the possibility to have high performance of students in biology (dependent variable). On the contrary, if these independent variables were handled anyhow, there would be the possibility to have low performance of students in biology (dependent variable).

## 2.3 Practical Activity/Inquiry in Science Education

### 2.3.1 Practical activity explained

By employing an activities-oriented approach, teachers offer students a variety of active educational experiences structured according to a learning cycle. This cycle consists of an instructional sequence that includes engagement, exploration, development, and extension (Guillaume, Yopp & Yopp, 1996; Gurganus, Janas & Schmitt, 1995). The learning cycle begins with the engagement phase, whereby teachers use real-life activities, problems and questions to motivate students to learn about the topic and to assess their prior knowledge. Students explore the content and phenomena by manipulating materials and start to address the presented questions. For example, in a lesson on simple machines, the teacher can ask students to identify simple machines that they use and have students take apart broken household appliances. During the exploration phase, students formulate new ideas and questions to be developed in the subsequent phases.

For example, teachers can have students explore how the household appliances work, identify their components, and formulate hypotheses about how to fix them. In the development phase, students add to their understanding by gathering more information and making conclusions about the concepts, phenomena, and questions previously generated. For example, students can use the Internet to learn more about the appliances and to draw conclusions about how they work. In the final stage, extension, students extend their learning by applying it to new and different situations as well as to their own experiences. For example, students can hypothesize about how other machines and household appliances work. Educators help students move through the learning cycle by asking them to think about questions, helping them find solutions, providing additional activities that increase students' learning, and aiding them in summarizing and evaluating their learning.

An integral part of the activities-oriented approach teaching and learning is providing hands-on, multisensory experiences and materials. Hands-on learning gives students concrete experiences that establish a foundation for learning more abstract concepts. These kinds of activities also help students actively explore and discover content and lessen the language and literacy demands that may interfere with learning for students with learning difficulties and who may be second-language learners (Fradd & Lee, 1995). For example, students can learn about electricity by building electric circuits or about earth science by creating models out of papier-mache. But, informal interviews (by the researcher) with some biology teachers in the Birim Municipality indicated that, most of them use the lecture method during biology lessons. The question remains that: has the lecture method given positive impact on academic performance of biology students in the Birim Municipality?

**2.3.2 Importance of practical activity/inquiry approach in science education**

For the purpose of this study, practical activity/scientific inquiry is described as a teaching and learning approach in which teachers create an enabling environment for students' curiosity and engage them in scientific investigations to solve problems that satisfy their ideas about the natural world.

According to Gott and Duggan (2003), "practical work is seen as the teaching and learning approach that develops procedural understanding as well as substantive understanding. Practical work allows learning by doing and is an important element to own self productivity. It provides opportunities for significant learning about oneself and the world."

Practical work allows learners to learn with understanding. Learners understand better what they have seen rather than what they were taught theoretically. During practical work sessions, learners touch and hold the equipment themselves and as such learn better by doing. The value of practical work has long been recognized at the secondary school level. Many teachers acknowledge the value of learning by doing rather than just being shown or told (Driver & Braund, 2002). If students can be allowed to do practical work in biology, then they would understand the content better, because students learn better by doing. They would remember better concepts they investigated with their own hands. This was further emphasized by Hodson (1990) who said that practical work is an essential component in the teaching and learning of science and vocational subjects. It is therefore advisable that students should be prepared with mastery of the skills required for practical work so that they will be ready for assessment. Hodson (1990) further added that in practical work the candidate performs certain activities in order to discover something as yet unknown, to test a hypothesis or to check an already known fact. In order to perform these activities, the candidate has to learn the skills required for practical work, which includes preparing and performing experiments and processing the results obtained.

According to Ottander and Grelsson (2006), the purpose of laboratory work in science education includes helping students learn science through the acquisition of conceptual and theoretical knowledge, and helping them learn about science by developing an understanding of the nature and methods of science. Laboratory work would, thus, enable students to do science using the ways of scientific inquiry. They increase support for purposeful learning complements, scientific theories and how to apply them. Furthermore, laboratory work is meant to stimulate the development of analytical and critical skills and create interest in science education (Ottander & Grelsson, 2006). For the interests of students in science to be increased and for them to become motivated to want to do science, there is the need for teachers to do practical work with them.

A large proportion of both primary and secondary pupils thought that practical work would contribute positively to general learning in science. They believe that practical work provided a usefully independent experience that supports learning. By doing practical work in science at school, students can find things out for themselves rather than the teacher telling them; practical science makes science more fun (Krathwohl, 1998).

The statement above by Krathwohl (1998) is true. From the researcher's experience, usually when it is time for practical work, most of the students are happy, and they usually become more curious and pay more attention than during the normal lecture lesson. In other words students find it fun when they are doing practical work, because they discover things for themselves.

We know that students enjoy practical work and that students are more likely to engage with science if they can see its relevance by doing experiments. Experiments sharpen students' powers of observation, stimulate questions and help develop new understanding and vocabulary. Practical work will also help all teachers of science subjects to share their skills and experiences of making experiments work in their classrooms (Hodson, 1990). Practical work with real objects and materials help teachers and learners to communicate information and ideas about the natural world, and also provides opportunities for students to develop understanding of the scientific approach to enquiry (Leach & Paulsen, 1999).

According to Ausubel & Novak (1968), the laboratory gives the students appreciation of the spirit and method of science, promotes problem-solving, analytical and generalization ability and provides students with some understanding of the nature of science. Science is about, 'seeing is believing' (Ausubel & Novak, 1968). So learners should see, for them to believe, not only learn facts without any supporting evidence. That is why practical work is essential in understanding science. Students for that matter need proper training and guidance in doing practical work. Furthermore, at the end of the final year of training and learning, learners in Ghana would be assessed practically.

It is therefore important that students should be allowed to do practical work in biology in order for them to benefit from those practical and be able to understand biology better. Teachers should therefore organize practical for the learners, and also for learners do practical for themselves if learners are to benefit from practical work.

Better still, Bell, Blair, Crawford and Lederman (2003) and Germann, Haskins and Ausl (1996) claim that developing scientific literacy for the citizens requires engaging learners in scientific inquiry for them to develop broad knowledge and understandings of the processes and nature of science. The National Science Education Standards-NRCS, (1996) notes that learners investigate, generate, ask authentic questions and construct reasonable explanations for the questions formulated through an inquiry approach in science teaching and learning. In that way, learners would understand the world around them and become scientifically literate. Also inquiry instruction in science enables learners to formulate their own questions, devise ways to answer them through data collection and analysis and then determine the reliability of the knowledge acquired (Edwards, 1997).

Lawson (1995) further indicated that through inquiry-oriented teaching, teachers could help learners to build their interest in the materials and activities, and to encourage their thinking, questioning and discussion for a variety of investigatory paths which fits the lesson content and learners' intellectual level with everyday social applications. Basically, scientific inquiry is central to science instruction (Welch, Klopfer, Aikenhead and Robinson, 1981). Hestenes (1987) describes scientific inquiry as a way of thinking about natural phenomena and the use of questions and experiments in testing plausible hypothesis to arrive at a logical conclusion. The National Science Education Standards (NRC, 1996) refers to scientific inquiry as:

> … the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Inquiry also refers to activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world (NRC, 1996, p. 28).

Thus, scientific inquiry involves students working scientifically through investigating, understanding and communicating (Hackling & Fairbrother, 1996; Queensland School Curriculum Council, 1999). Literature in science education describes three levels of inquiry-based teaching and learning. These include structured inquiry, guided inquiry and open inquiry (Hackling & Fairbrother, 1996; Colburn, 2000). Colburn (2000) describes structured inquiry as one in which the teacher engaging students in problem-solving activities and provides them with the procedures and materials to discover and generalize on their own from data collected. Essentially, the approach prescribes what students are to observe and which data they are to collect. Guided inquiry, on the other hand involves the teacher providing only the materials and the problem to investigate while the students manipulate the materials and solve the given problem on their own. Open inquiry is similar to guided inquiry with the addition that students also formulate their own problem to investigate. Open inquiry, in many ways, is similar to doing science and a typical example of student open inquiry being the science fair or science talent search projects (Hackling, 1998; Hackling & Fairbrother, 1996).

### 2.3.3 Differences between inquiry-based and traditional approaches in science

Over the years, research in science education has compared inquiry-based and traditional teaching and learning approaches in science (Lott, 1983; Shymansky, 1984; Kaiser, 1996; Chang & Mao, 1998). A typical example is that of Lott (1983). Lott conducted an analysis of 39 studies involving expository and inquiry-oriented approaches in science and found that teachers who encourage inquiry approaches in their teaching have students who perform better than those taught using traditional approaches when higher-level cognitive processes were emphasized, but performed equally well on low-level cognitive processes. Thus the inquiry-based approach helps to develop higher-level cognitive skills in learners and improves learning outcomes among students.

In Nigeria, the inquiry approach has been recognized as a crucial teaching strategy for improving students' learning of science (Federal Ministry of Education-FME, 1985; Federal Government of Nigeria-FGN, 1998). The National Policy on Education-FGN (1998) affirmed that teaching of science in schools should be by guided- discovery and inquiry approaches. However, studies indicate that inquiry teaching and learning approaches are rarely practiced in Nigerian science classrooms because of the lack of resources for effective practical work, among other factors (Teibo, 1973; Ajewole, 1994).

Teibo (1973) notes,

> many ….teachers hardly arrange any laboratory work for their pupils probably because preparation for laboratory work makes much demand on their time and energy……The rigid, laborious and descriptive nature of science teaching and learning has discouraged many intelligent students from pursuing their study of this discipline (Teibo, 1997, p. 49).

Yager (1991) also affirms that most teachers know that inquiry is something that real scientists do, something that reformers have championed throughout their professional lives. And yet it remains something elusive; something that is poorly defined something so broad that all can truthfully say they are doing some of it.

Ogunbowale (2001) points out that the broad scope of the science curriculum and emphasis on the quantity of content coverage are the major constraints to inquiry approaches in science teaching and learning in Nigerian schools. However, the literature suggests that when teachers teach less content, they teach it better by introducing ideas in a variety of ways and thus encourage students' learning (Rutherford & Ahlgren, 1990; Wenning, 1997).

### 2.4 Teaching Methods in Science Education

The essence of teaching is to bring about a positive change in the behaviour, attitude and thinking of the learner. The teaching approach that the teacher adopts in order to bring about this positive change is very important. There are as many different kinds of teaching methods as there are teachers. Many studies have revealed that teaching activities are usually represented by teachers' teaching attitudes and their preferences regarding teaching methods (Rutherford & Ahlgren, 1990; Wenning, 1997). Carkhuff& Berenson (1981) stated that some teachers emphasize the use of question and answer techniques; others use a lot of programmed instruction. Still others utilize the lecture method in the science classroom and using overhead projectors a great deal. In a very real sense, each teacher uses a different teaching method. Weston and Cranton (1986) concluded that programmed instruction is most effective at lower levels of learning, and that independent projects are appropriate at higher levels of learning, and these methods are flexible to the differences in learners. Odubiyi (1988) summarized the experiential learning methods in a study by Weston and Cranton (1986) as comprising field/clinical experience, laboratory experience, role playing, simulations and drill. These methods require careful planning and precision at the secondary level.

Moreover, there is a traditional teacher-centered lecture (chalk-and-talk) approach, which emphasizes the transfer of knowledge and skills and rewards memorization. This is the predominant teaching format used in secondary schools (Chonjo, Osaki, Possi & Mrutu, 1996). In this approach, the teacher talks most of the time, while a student jots down notes mainly for the purpose of passing exams. This method does not allow for much critical analysis of issues but it makes students to duplicate the notes given back to the teacher. In this teaching approach, there is very little interaction between the teacher and the students or among the students themselves in the classroom. Students hardly ask any questions and the teacher rarely provoke students by asking critical questions.

Again, a study done on science teaching in Tanzania revealed that most teachers used transmission (chalk-and-talk) rather than interactive, learner-centered pedagogy (Osaki, 2000). Teachers were seen to be authoritative, dogmatic and inflexible (Chonjo *et al.,* 1996). Their teaching emphasis in lectures was to convey science content, and in some cases technical training for acquiring practical skills. The problem is furthered by the cultural belief system in which teachers are regarded as elders and are to be respected and not challenged by students.

In another study, Osaki (2007) found that in many schools, students read teachers notes instead of text books, and hence teachers are the main source of information and knowledge. The students may have textbooks, but choose to rely on teachers notes. These notes often encourage rote learning in order to pass examinations. The use of textbooks by students for reference and homework is not always effective especially for those in forms one and two (Ungar, 2010). Although students bring textbooks to class; teachers rarely give any tasks requiring them to make use of the text book during the lesson. Some students may read the text books regularly but when reviewing for tests and exams they revert to reading the teachers' notes (Osaki, 2007). In the classroom science is usually presented as a rigid body of facts, theories, and rules to be memorized and practiced, rather than a way of thinking about and understanding natural phenomena (Sutton, 2011).

Furthermore, teaching and learning approaches such as Behaviorism, Cognitivism and Constructivism are also adopted by some science teachers during teaching and learning (Ministry of National Education, 2006). Next is a thorough discussion on these three approaches/methods of teaching in science.

**a) Behaviorist Approach**

Behaviorist theories that dominated the field of psychology during the first half of the 20$^{th}$ century are based on the philosophical views of Aristotle, Descartes, Lock and Rousseau on the nature of learning. These theories emphasize that by changing the environment the desired behavior can be achieved. In addition to the names above, among the pioneers of behaviorist approach are Pavlov, Watson, Thorndike and Skinner (Demirel, 2007).

In this approach, learning is explained on the basis of action-reaction principle. Cognitive processes are not given much importance. Therefore, according to this approach, there is no difference among learners in terms of understanding. In the universe there is stable knowledge and the aim of education is to transfer this knowledge exactly to students and students are supposed to receive this knowledge without questioning. In addition to this, behaviorists see learning as an observable change in the behavior of the individual. Objectives are determined for students and they are expected to fulfill these objectives and organize their behaviors accordingly. Moreover, education focuses on external conditioning (Deryakulu, 2001).

**b) Cognitive Approach**

The theorists of cognitive approach, in which Piaget, Bruner, Vygotsky and Guilford are pioneers, emphasize the complexity of human behavior and claim that the “action-reaction” principle in the behaviorist approach is unsatisfactory in explaining learning (Demirel, 2007).

According to the cognitivist, knowledge, which is perceived from outside environment through sensory organs is processed in the brain just like a computer processing data. This knowledge processing has 2 main elements: The first one is knowledge storages formed in the memory and the other one is cognitive processes that help the knowledge to be transmitted to other memories (sensory, short-term and long-term) and that involve cognitive activities (Senemoğlu, 2010).

The psychologists in favor of this opinion believe that learning is the result of our effort to give meaning to the events and situations around us and thus, we use all the mental tools we have (Demirel, 2007). Demirel (2007, p. 229) states that, according to this approach, the basic opinions below are adopted:

1. Learner is not a passive receiver of external stimuli but he/she is the one who assimilates them and actively forms behaviors.
2. Learner is the one who takes the responsibility of his/her own learning, and he/she does not receive what is given as it is but discovers the meaning of what is given.
3. Learner is the person who chooses the suitable ones among the different pieces of knowledge and processes them.

4. Learner, even if it is a principle that is aimed to be acquired by him/her, has to give meaning to that principle by trying to find the meaning of it, relating it to other principles and associating it with the principles he/she has learnt before.

**c) Constructivism**

"Constructivism" means that students construct the knowledge; they do not receive it as it is but they re-form it again. They learn the new knowledge by adapting it to the existing knowledge and their own situations. Brooks and Brooks (1993) state that when a learner comes across a new piece of knowledge, he/she uses the rules formed earlier in order to define and explain the world or forms new rules in order to explain better the knowledge he/she perceived. In addition to this, a learner puts into practice the knowledge constructed, by bringing the already learnt knowledge and newly learnt knowledge together in order to solve the problems in life (Perkins, 1999).

In the constructivist approach, the aim is not to pre-determine what learners will do, but to provide individuals with the opportunity to direct their own learning process through tools and learning materials (Erdem, 2001). According to Wilson (1993, p. 23), in general terms constructivism is based on:

1. the nature of reality: mental representation refers to "real" world
2. the nature of knowledge: knowledge is constructed in individuals" minds
3. the nature of human interaction: meanings are shared; that is, they are cooperative rather than being authoritative or manipulative
4. the nature of science: meaning is made after it passes through the individual's own filters

In general, the comparison of behaviorist, cognitive and constructivist learning approaches are listed in Table 1.

**Table 1: General Characteristics of Behaviorist, Cognitive and Constructivist Learning**

| S/No. | Basic Characteristics | Behaviorist | Cognitive | Constructivist |
|---|---|---|---|---|
| 1. | Quality of Knowledge | Based on objective reality, independent from the knower | Based on objective reality, depends on the knower's pre-knowledge | Based on subjective reality constructed individually and socially |
| 2. | Role of the teacher | Knowledge transfer | Managing the knowledge acquisition process | Helping students, being in cooperation with them |
| 3. | Role of the student | Passive | partially active | Active |
| 4. | Learning | Change in the open behavior as a result of conditioning | Knowledge processing | Individual discovery and construction of knowledge |
| 5. | Teaching type | Separation, generalization, association, | Processing knowledge in short-term memory, storing knowledge in long-term memory | Problem solving based on real life situations |
| 6. | Teaching type | Inductive | Inductive | Deductive |
| 7. | Teaching Strategies | presenting knowledge, providing exercise, giving feedback | triggering student's cognitive learning strategies | effective, with self-control and internal motivation, research based learning |
| 8. | Education environments | Several traditional environments (programmed teaching, computer aided teaching etc.) | Teaching based on teacher and computer | Interactive environments requiring students to show physical/ mental reactions to improve |
| 9. | Assessment and Evaluation | Separate from teaching process and based on a measure | Separate from teaching process and based on a measure | Within teaching process and independent from a measure |

**Source: (Seels, 1989; Scheurman, 1998; cited in Deryakulu, 2001).**

Some research studies suggest that factors inside and outside the classroom affect students' achievement and interest. For example, Orleans (2007) asserts that the key factor in what comes out at the end of schooling is what goes on in the classroom. Mills (2002) as cited in Wambugu and Changeiywo (2008) states that teaching methods are crucial factors that affect the academic achievement of students, and no matter how well-developed and comprehensive a curriculum is, its success is dependent on the quality of the teachers implementing it (Ughamadu, 2005; Ajaja, 2009). In its attempt to help improve upon the teaching and learning of the sciences, the Ghanaian Government in 1987, implemented an Educational Reform nationwide with the aim of providing a system of education that would serve the needs of the individual, the community and the country as a whole (Tuffour, 1989). Tuffour (1989) reported that, though there were some challenges (after almost two years of implementation) the implementations of the JHS (formally called Junior Secondary School-JSS) science program made a considerable success such as recruitment of teachers for all the schools, the supply of inputs (namely science syllabi, textbooks and laboratory kits), the effect of orientation for teachers and the general interest of teachers in the program.

Similarly, the government of Ghana in 1995, through the Ministry of Education (MOE) and Ghana Education Service (GES) established Science Resource Centres (SRCs) in 110 SHS spread throughout the country. Each centre was intended to be used by a number of SHS known as satellite schools within a 40-kilometre radius depending on the population of the schools. This project was initiated to help bridge the gap between schools with well-resourced science laboratories (both human and material resources) and those with little or no resources; hence, ensuring equity in students' learning across the rural-urban divide (Ministry of Education, 2004). The SRCs were equipped with basic science equipment including modern electronic devices and computers to be used in the teaching and learning of science, including biology, and thereby improving students' performance. In addition, buses were provided to all SRCs for use by satellite schools (Ampiah, 2004). After almost two decades of its (SRCs) implementation, performance of students in the science, with Biology in particularly, has not been any better as indicated earlier. It is not clear where the responsibility lies as little is known about biology teaching in the SHS. It would be interesting, therefore, to investigate the impact of practical activities on the academic performance of biology students in the Birim Central Municipality.

In summary, practical activities in biology provide opportunities for students to actually do science as opposed to learning about science. Nzewi (2008) asserted that practical activities can be regarded as a strategy that could be adopted to make the task of a teacher more real to the students as opposed to abstract or theoretical presentation of facts, principles and concepts of subject matters. Nzewi (2008) maintained that practical activities should engage the students in hands-on, mind-on activities, using varieties of instructional materials/equipment to drive the lesson home. Nwagbo (2008) stated that:

> The use of practical activities (approach) to the teaching of biological concepts should therefore be a rule rather than an option to biology teachers, if we hope to produce students that would be able to acquire the necessary knowledge, skills and competence needed to meet the scientific and technological demands of the nation (Nwagbo, 2008, p. 41).

The search for a more effective approach for the teaching and learning of Biology that would enhance the acquisition of process skills has persisted over the years. This is because, the acquisitions of science process skills are the bases for scientific inquiry and the development of intellectual skills and attitudes that are needed to learn concepts. It is in the light of this that this study is conducted here in Ghana.

**2.5 Effects of Practical Activities on the Academic Performance of Students**

In a research by Fabio and Laura, (2010) on analysis of factors affecting pupils' science achievement in Italy, the relationship between contextual factors at the school level and pupil level and the proficiency scores for science achievement was examined. In their findings, in Italy 34% of the total variance accounted for, was between schools and that, the school and teacher factors analyzed do not significantly affect pupils' performance in science. In the Italian context, being a non-native student and having less cultural resources negatively and substantially affects science performance and is consistent with several studies pointing out the advantages deriving from home and parental features. The researchers also found that students self confidence in learning science proved to be the most important predictor of their performance. Research into educational psychology also shows that teachers can improve students' self-confidence and self-efficacy by means of specific teaching methods such as engaging students in a creative manner and using collaborative learning or inquiry-based activities (Fencl & Scheel, 2005). But, findings of Fabio and Laura (2010) cannot not be accepted here in Ghana due to cultural differences between Italy and Ghana. Also, pupils (basic school learners) were the participants for that study while this current study used students (Senior High School learners). Likewise, their study was on science in general but this current study is on biology in particular; hence, the need for this study to be conducted.

A similar study was carried out in Nigeria by Akinola (2006), where the findings revealed that performance in science subjects was very poor in the secondary schools. Among the factors that contributed to this poor performance were inadequate learning facilities in the secondary schools which include science equipment and laboratories, shortage of qualified and devoted instructors, lack of ability of the scholars to do well in practical and the teaching methodologies used by the teachers. Again, findings of the study revealed that, most of the text books used in secondary schools were written by foreign authors who use complex language which is difficult for the learners to comprehend. Also, in Malawi, poor performance in science subjects has been in the decline due to the following factors: lack of science equipment, lack of enough and quality text books, students' perception that science subjects are hard, student's laziness and too little time allocated to practical lessons (Dzana, 2012).

A study on factors associated with high school learners' poor performance by Andile and Moses (2011) in South Africa showed that, education and training during apartheid was characterized by the underdevelopment of human potential and that of blacks in particular. The teaching and learning of mathematics, science and technology were the hardest hit (Department of Education-DOE, 2001). The researchers classified the factors that led to poor performance into two; direct influences which included teaching strategies, content knowledge and understanding, motivation and interest, laboratory usage and syllabus non completion. The indirect influences include parental roles and language. Thomas and Pedersen (2003) argue that a common adage in the educational profession is that one teaches the way he was taught. This suggests that, for example an educator who was educated in an incompetent manner will have learnt bad practice and is likely to use such in teaching others.

Responses from teachers showed that teachers qualification and students environment do not influence students poor performance but teachers' methods of teaching influences poor academic performance. Students' responses on the other hand, showed that teacher's methods of teaching and learning materials contributes to poor academic performance. The variables that were identified in the study for research questions and data collection instruments were: students' poor academic performance and teachers' qualifications, students' poor academic performance and teachers' method of teaching and students' environment and poor academic performance. These factors formed the basis for comparison with the factors causing poor academic performance among biology students in Ghana.

Furthermore, Wabuke (2009) conducted a study on the topic "The role of student-related factors in the performance of biology subject in Secondary Schools in Eldoret Municipality, Kenya". And established that, student-related factors affecting performance in biology are: primary school science which provides a requisite background for biology at secondary school level; interest in biology which provides a force for learners to participate in the learning process, their ability to carry the practical effectively and students' ambition and attitude towards biology. Other student-related factors were availability of reading materials, student using study timetables and organizing their work, study discussion groups and attending science symposiums, field trips and then exhibitions. The study also established that absenteeism, indiscipline and truancy in students accounted for poor performance.

The relationship between availability of teaching/learning resources and performance in secondary school science subjects was investigated by Ambogo (2010). In his study, he examined the relationship between availability of both human and non-human resources for teaching/learning and performance in the science subjects in Kenya Certificate of Secondary Education (KCSE) examination. From his findings, availability of text books, laboratory chemicals and equipment was higher in the high performing schools than in the low performing schools. The findings showed that two out of the seven low performing schools with science laboratories, five low performing schools that had a science laboratory did not have a laboratory technician; and only one had a fully equipped. There were differences in the availability of teaching and learning resources. The author recommended that the ministry of education should initiate more training programs in provision, improvisation and utilization of teaching/learning resources and should help enhance the ongoing science programs.

Factors influencing students' academic performance in community and government built secondary schools were investigated by Mlozi and Nyamba (2008) Mbeya Municipality, Tanzania, who had almost the same findings. The research assessed the adequacy of school inputs; the learning processes in schools, compared students' academic performance in Form 2 and 4 National Examination results in 2006-2008; and explored people's perceptions on community funded secondary schools. In their findings, there were no enough teaching and learning materials, teaching and learning processes were poor especially in the community funded secondary schools; availability of facilities in the schools did not match with the number of students and teaching was dominated by a mixture of English with Kiswahili whereas the exam was set in English language. Their findings showed that academic performance of community funded secondary schools were poorer than government built secondary schools in Form 2 and Form 4 National Examinations from 2006 to 2008. The researchers recommended that the government should increase the number of teachers, provide teaching/learning materials such as text books, laboratories and classrooms. Their findings are relevant to this research since the factors identified here are similar to the factors that contribute to poor performance in science subjects in Secondary Schools in Tanzania.

In a research by Cyril and Lucas (2010), factors influencing academic performance in ward secondary schools were investigated. The study focused on the link between education providers, facilitators and learning environment (which includes all facilities and infrastructure availability of materials) and performance of ward secondary schools. The study found out that there was no impressive performance among ward secondary schools in the district. Some of the challenges that limit their performance included: limited number of teachers per subject compared to the number of students, lack of conducive teaching and learning environment and shortage of teaching and learning materials. Other factors were lack of well stocked libraries and laboratories, poor communication between teachers, parents and students; and poor class attendance by both teachers and students. Based on their findings they concluded that there is need to collect more information in order to have a good generalization and better understanding of factors affecting academic performance in the ward secondary schools in Tanzania.

More so, Mkumbo (2010) conducted a study on the topic “Relationship between examination practice and curriculum objectives in Tanzania”. The research involved, among others content analysis of curriculum materials and examination papers to establish the linkage and synergies between the two aspects of education processes in Tanzania; and the linkage between curriculum practice and learners’ performance in examination performance.

Findings of the study were that, resources used to implement the competency based curriculum were ineffective. It was therefore recommended that textbooks, modules and manuals, reference books, charts, maps, newspapers and journals be used by teachers. It was further recommended that, teachers should be encouraged to use ICT facilities in schools, scientific and creative teaching facilities such as samples and actual materials, prototypes and laboratory apparatus.

In conclusion, poor performance of students in science subjects in secondary schools is an issue that has been well known and discussed by many people globally. Even though a lot of researches have been carried on how to improve the performance of science students, it seems the performance keeps on dropping in most SHS especially in Ghana. There have been complaints by the public that the students are performing badly in science and worse in biology (Ajaja, 2009). Therefore, there is the need to conduct research to identify the major reason contributing to this problem in our Ghanaian contest and come up with permanent solutions to resolve the matter.

### 2.6 Challenges Faced by Science Teachers in using Practical Activities

Science teachers can teach different science subjects at secondary level. These teachers would usually have specialized in one particular area at university level. Therefore in many cases they will be teaching within their area of expertise or outside their subject specialism, meaning that one has not studied this subject at degree or at pre-university level. Teaching outside area of expertise offers considerable challenges and teachers express concern and apprehension when dealing this situation. Teachers' lack of confidence when teaching topics outside their area of expertise is manifested in different ways including lesson plans, choosing or devising activities and analogies to aid students' learning, answering students' questions, setting up laboratory experiments, linking and applying various concepts and principles to everyday life situations, generating students' interest and passion for the science area.

Teachers teaching outside their area of specialization face considerable challenges in lesson preparation and science teaching itself. First of all these teachers need to understand the structure and nature of the discipline and learn unfamiliar content knowledge, which is known as subject matter knowledge. Secondly, they need to transform the content knowledge into suitable activities, analogies, demonstrations or simulations and adapt them to the different students' abilities to help them learn, what is described by Shulman (1987) as pedagogical content knowledge. This review outlines the challenges faced by science teachers when teaching outside their area of expertise and to explore the strategies used by teachers in dealing with such situations. Inadequate background in the subject knowledge is one of the main factors that contributes to such challenges and will have an impact on the development of the teachers' pedagogical content knowledge as well as on the teachers' self-confidence and attitudes when teaching topics outside their area of expertise. The teachers' knowledge base strongly influences all aspects of teaching like preparation, planning and decision making regarding the choice of content to be taught (van Driel, Beijaard & Verloop, 2001).

The knowledge base for teaching is made up of seven categories, which include subject matter knowledge (SMK), pedagogical content knowledge (PCK), curricular knowledge, general pedagogical knowledge, knowledge of the learners and their characteristics, knowledge of educational contexts and knowledge of educational purposes (Shulman, 1987). According to Shulman (1987) SMK is based on two main areas: the organization of concepts, facts, principles and theories and the nature and structures of knowledge which refer to the ways in which truth or falsehood, validity or invalidity are established (Shulman, 1986). In other words, the teachers' SMK incorporates not only knowledge of specific topics of the curriculum but also knowledge about the epistemology of science or the nature of scientific knowledge. Therefore, one can argue that one of the most important characteristics of being a good science teacher is having a very good basis of subject matter knowledge (SMK).

However, research studies suggest that while a good background in SMK is a pre-requisite for good teaching, it is not the only requirement (Abell, & Smith, 1994; King, & Newmann, 2000; Hausfather, 2001; Childs & McNicholl, 2007). King and Newmann (2000) contend that high academic performance in a specialist subject is not an automatic precursor to good teaching. In fact, subject specialists are more likely to resort to teaching through a process of knowledge transmission which is not enough for deep learning to take place. Exemplary science teachers, as argued by Shulman (1987) also need to develop PCK which enables science teachers to blend "content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented and adapted to the diverse interests and abilities of learners and presented for instruction (Shulman, 1987).

Magnusson (1999) described pedagogical content knowledge (PCK) for science teaching as the transformation of several types of knowledge not only subject matter knowledge (SMK). These knowledge areas consist of five components which include orientation toward science teaching, knowledge and beliefs about the science curriculum; knowledge about assessment in science; knowledge about students' understanding and misconceptions of specific science topics; and knowledge about instructional strategies for teaching science or topic specific pedagogy. Pedagogical content knowledge (PCK) develops with teachers' experience (Abell, 2008; Davis, 2003). It is a cyclical process whereby teachers transform, reflect and evaluate their practice and continue to learn as they develop their practice. Pedagogical content knowledge (PCK) is also content–specific or subject-specific knowledge that is fundamental to effective science teaching (Magnusson, 1999). Subject-specific knowledge entails general strategies applicable to teach science. Content-specific strategies, such as illustrations, models, analogies, experiments and activities are required when teaching particular topics within a science field. Abell (2008) acknowledges that PCK differs from one discipline to another, for example teaching biology is different from teaching chemistry. This implies that when teachers teach outside their area of expertise they also need to develop different instructional strategies (one of the components of PCK). Having a limited knowledge of topic-specific representations can negatively impact on science instruction (Magnusson, 1999).

Research studies about teachers teaching science topics within and outside their areas of specialization highlight important differences in the quality of preparation and delivery of science lessons. Common challenges encountered by trainee or experienced teachers can be identified from different studies (Childs & McNicholl, 2007; Kind, 2009; Kind & Kind, 2011; Hasweh, 1987; Sanders, Borko & Lockard, 1993). A study by Hashweh (1987) with six experienced secondary school teachers preparing to teach topics within and outside their area of expertise showed remarkable differences in planning, response to students' questions and conduction of lessons based on their prior SMK. Within their field of expertise, teachers had a wide knowledge base of the subject, knew the subject in more depth and were able to draw links between different areas of knowledge in the same subject discipline.

More knowledgeable teachers made many modifications to science teaching according to the way they developed their schemata of SMK. They could expand activities or generate their own activities, ask higher-level questions, detect students' misconceptions and deal effectively with students' difficulties. On the other hand, teachers teaching outside subject specialization, with lower background SMK, followed the textbook structure quite closely, could not generate new activities and asked recall questions. They could not detect students' misconceptions and in some cases they reinforced these ideas. This is in line with another study conducted by Van Driel, De Jong and Verloop (2002) where teachers with good content knowledge were also more aware of the students' difficulties and misconceptions and were able to make use of strategies to induce conceptual change.

Kind (2009) also reported that trainee teachers felt less confident at trying out new things, they were less creative and did not develop their own ideas in preparing lessons outside their area of expertise but followed the traditional methods. In a study by Childs and McNicholl (2007) with novice and experienced teachers, lessons outside subject specialization were tightly controlled and included less discussions, open-ended questions, anecdotes, illustrations and analogies. Practical work was closely directed and textbooks were used more often. Lessons taught outside of subject specialism were perceived to be rigid and constrained.

One of the striking findings in the study conducted by Childs and McNicholl (2007) was that teachers regardless of their experience faced similar issues and challenges when teaching outside subject specialism. These findings are consistent with the findings of another study conducted by Sanders *et al.,* (1993) with three experienced teachers teaching within and outside their area of expertise. Experienced teachers sometimes acted like novice teachers when teaching outside subject specialism. They encountered difficulties in planning lessons because they were uncertain of the time required to develop different concepts, how to sequence the content, how concepts were interrelated and had difficulties in deciding what was important. Lessons outside area of expertise did not flow as smoothly as within their area of expertise. They made quick and frequent changes and were sometimes unable to build explanations in response to students' questions.

Similarly, in other studies by Kind (2009) and Kind *et al.,* (2011), trainee teachers were also concerned in answering subject-related questions and the ability to handle questions depended on their self-confidence. When teaching outside subject specialism, lessons were more teacher-dominated and more time was devoted to teacher explanations (Sanders *et al.,* 1993). Less risky instructional activities were planned for unfamiliar content as opposed to more student-centred activities and less teacher talk when teaching within familiar areas. However, experienced teachers could manage their classrooms better than novice teachers. They made use of their science process skills, laboratory organization, handling equipment, classroom management and group arrangements better than novice teachers. Unlike beginner-teachers they did not rely on textbook presentations but used various resources.

Hence they were able to draw upon their general pedagogical practice to provide a framework for their teaching within and outside area of expertise and supplement it with content knowledge and PCK.

Practical work was another area of concern in Childs and McNicholl (2007). Teachers felt that they lacked knowledge about technical and safety details. They were also anxious about how to deal and explain unexpected or wrong results due to their lack of confidence in the subject. Experienced teachers were concerned about their ability to make links between the different areas of the science curriculum due to their impoverished view of the subject. Having an in-depth knowledge of the subject matter helps teachers provide alternative explanations or use different approaches to help students understand complex scientific concepts. Teachers felt restricted in their explanations, in the range of activities and in illustrations provided when teaching outside subject specialism (Childs & McNicholl, 2007; Kind, 2009).

The above studies construct a picture of science teaching outside a teacher's subject specialization as limited, unadventurous and lacking cognitive challenge (Childs & McNicholl, 2007). These studies show that the level of SMK greatly influences how the subject is taught (Kind *et al.,* 2011). Davis *et al.,* (2007) argue that when teachers have stronger subject matter knowledge, they are more likely to engage in sophisticated teaching practices.

The state of science education for adolescents is at an important crossroads. In this 21st century, enormous scientific challenges are confronted by the youth of today. Some of these issues include the expansion of the HIV/AIDS pandemic, global climate change, world hunger, space exploration, and the development and implementation of alternative energy sources. Whereas the need for scientific advances is at its peak, adolescent learning about science in school is facing critical challenges. Science educators in the early 21st century are facing a myriad of issues. Indeed, students still lag behind in science achievement, particularly in the European and Asian countries (National Center for Education Statistics, 2007). Some of the complex issues in the field of science education include the availability of appropriate textbooks and classroom resources; the preparation and training of science teachers (including both pre-service and in-service professional development); political and religious opposition to cutting-edge science instruction; the need to meet standards and to prepare students for standardized examinations; and the dramatically increasing use of the internet as a source of information. Given these and other issues, it is extremely important to understand, acknowledge, and build upon the abilities of adolescent learners, while at the same time tailoring instruction to address the unique challenges faced by this age group.

The field of educational psychology has much to contribute to science education. There have been many important recent developments in the study of adolescent cognition and motivation, and this new knowledge has much to add to the enhancement of science education. Learning about science requires the coordination of a complex set of cognitive, affective and motivational strategies and skills. Specifically, research from educational psychology can contribute greatly to our understanding of how adolescents acquire and process scientific knowledge; overcome misconceptions; learn the discourse of scientists; learn to think and reason like scientists; evaluate sources of scientific information; and reconcile personal beliefs (religious and political) with science content.

This comprehensive report documents research-based recommendations for improving science learning for young children and early adolescents. This excellent resource covers much important information, and serves as an excellent platform from which to begin considering the unique needs of older adolescent learners. The development that occurs in the cognitive, social, and physiological domains during adolescence is remarkable. Given these salient changes, it is important to note from the outset that adolescent science learning and instruction (particularly late in the middle and high school) differs from K-8 science instruction in at least three important ways. First, adolescents' emerging cognitive abilities present unique challenges for science educators. Second, secondary science teachers usually are trained in a specific scientific discipline (a science teacher might have an undergraduate degree in biology or chemistry), compared to K-8 science teachers, who usually are trained in general teacher education programs. A third distinction is that the depth and breadth of science content for late adolescents affords the opportunity to build upon previous learning progressions through specialized electives (e.g. Physical Anthropology or Biotechnology) and enrollment in multiple science courses simultaneously. These distinctions between young science learners and adolescents afford educators the opportunity to promote greater appreciation of science as a discipline, and encourage students to consider science-related careers.

A study in Australia by Goodrum (2001) claim that large class size, limited resources, inadequate time for preparation, reflection and teachers' collaboration with colleagues limit the use of practical activities in teaching science in secondary schools.

It is worth noting that quality teaching and learning of science in schools cannot be achieved in a vacuum but requires adequate resources, improved teacher preparation, small class sizes, ongoing professional development for science teachers and the recognition of the importance of science education in society, among others. Improving the quality of teaching and students' achievement in science depends on the quality of initial teacher education, mentoring and induction programs provided for beginning teachers, opportunities for ongoing professional development provided for teachers, teaching resources in schools and community support among other factors.

Literature in science education has continued to claim that teacher quality is the most important factor that inhibits the quality of science education (Darling-Hammond, 1997; Darling-Hammond & Ball, 1997) and that most teachers lack adequate background knowledge in the fields they are asked to teach or sufficient skills for the students they need to teach (NRC, 1996). Schoon (1996) notes that effective science teachers have the knowledge of the learner, subject matter content, teaching pedagogy, school and the school environment. Bryan, Abell and Anderson (1996) claim that prospective science teachers have different beliefs and knowledge about teaching and learning before entering teacher education programs. Kanstoroom (1999) also argues that a large portion of today's teachers are unprepared for the challenges that await them in the classroom. Thus, today's teachers need higher levels of education, skills and knowledge in teacher education programs and improving the quality of the initial teacher education should be a priority.

Shulman (1987) argues that teacher education programs should comprise knowledge of subject matter (content knowledge), knowledge of teaching the subject (pedagogical knowledge) and the knowledge of the subject matter and its teach ability (content-pedagogical knowledge).

Anderson and Mitchener (1994) note that variation in teachers' prior scientific and pedagogical knowledge beliefs is as a result of lack of articulation and coordination between content knowledge and pedagogical knowledge during their initial teacher education programs. Yager and Penick (1990) also identified lack of coordination in the nature of methods, courses, practicum experiences, and the role of placement of clinical experiences as the immediate problems facing science teacher education that need to be addressed for quality science education (Yager & Penick, 1990). Rosario and Ison (1991) therefore claim that quality teacher education programs should include field-experience in which pre-service teachers would be mentored by a master teacher and should be able to observe exemplary teaching in progress.

## 2.7 Strategies Used by Science Teachers to Deal with Challenges Inherent in Practicals

When facing unfamiliar science content, teachers resort to a range of strategies to deal with these challenges (Childs & McNicholl, 2007; Kind, 2009). During the planning stage, they mainly read textbooks, teachers' resource packs and schemes of work, which offer various ideas of lesson plans and activities; they also outline links between lessons across the topic. They also seek help and advice from school colleagues who are subject specialists, especially about practical work and conduct trail experiments. Support from the workplace was found to be the most popular strategy to help teachers deal with their weaknesses in subject matter.

Kind (2009) notes that about 50% of trainees actively sought advice from school colleagues when teaching outside area of expertise. On the contrary when teaching within their subject area, trainees read textbooks to gauge students' knowledge levels, relied mainly on their prior knowledge, consulted less their colleagues and rarely tested experiments prior to their teaching.

Since trainee teachers consulted more resources when preparing lessons outside their area of specialization they produced more successful lessons. They managed to successfully transform the learnt SMK to PCK when they delivered lessons with suitable activities that met the students' learning objectives.

Some research studies have also attempted to find a correlation between teachers' self-confidence to teach the different sciences and the level of content knowledge (Appelton, 1995; Harlen & Holyrod, 1997; Kind *et al.,* 2011). Studies with secondary school science teachers are scarce compared to studies carried out with elementary teachers. Appleton (1995) found that elementary teachers gained more confidence not only when they experienced success in learning science content but also when they experienced how the subject is taught after undergoing a science method course. This highlights the importance of developing PCK. Harlen and Holroyd (1997) state that confidence in a specific area of content is closely related to knowledge of that content. However, confidence is also influenced by other factors such as school and personal experiences, the nature of initial and in-service experience, pressure of curriculum overload, support from colleagues, material resources and the teacher's own view of professional capability. This last factor refers to the teachers' perceived self-efficacy.

Bandura (1997) defines self-efficacy as the beliefs in one's capabilities to organize and execute the course of action required to produce given attainments. The theoretical framework of self-efficacy is embedded in social cognitive theory. Self-efficacy beliefs have two dimensions. They indicate the level of self-confidence in teacher's own teaching abilities, known as personal science teaching self-efficacy (PSTE).

They also reflect the belief that, students learning can be influenced by effective teaching, which is known as the science teaching outcome expectancy belief (STOE). Teachers' behaviour is based upon these two dimensions of self-efficacy beliefs. According to Riggs and Enochs (1990) teacher efficacy beliefs appear to be dependent upon the specific teaching situation. Therefore, teaching within or outside area of specialization would affect teacher's self-efficacy and self-confidence. In the study by Kind *et al.,* (2011) some trainee teachers, preferred teaching their specialised subjects and were anxious in teaching the other sciences.

Most secondary school teachers in Kind's study (2009) expressed concern in answering subject-related questions on unfamiliar topics and worked hard to improve their knowledge weaknesses to gain confidence. Teachers' confidence when teaching topics outside their area of expertise is affected by the limited repertoire of appropriate explanations and demonstrations and by the limited ability to make the links between lessons and across scientific concepts (Childs & McNicholl, 2007).

In conclusion, these research studies have shown that there are considerable differences when teaching within and outside area of expertise. Teachers seem to be more self-confident when teaching within their subject specialization. This phenomenon is present in many countries.

In Malta, many science teachers have a teaching degree specializing in physics and science. A number of these teachers would have never studied Chemistry at secondary level, since physics was the compulsory science subject. Hence many teachers teaching integrated science to students aged between 11-13 expressed similar concern, apprehension and lacked confidence when teaching topics related to science areas that are not in their area of specialization (Mizzi, 2005; Gatt, 2011).

It would be interesting to conduct an in-depth research study with these teachers and devise strategies to how such teachers can be supported in order to increase their level of confidence when teaching outside their area of expertise.

## 2.8 Chapter Summary

This chapter dealt with literature review related to the study. The literature was discussed under the sub-headings: theoretical framework, conceptual framework, concept of practical activities/inquiry in science. It also dealt with concept of teaching methods in science education, effects of practical activities on the academic performance of students. The chapter also focused on challenges faced by science teachers in using practical activities, strategies used by science teachers to deal with such challenges and finally, chapter summary.

# CHAPTER THREE

# METHODOLOGY

## 3.0 Overview

This chapter presents the methodology of this study. Silverman (2005:99) defined methodology as, choices we make about the cases to study, methods of data gathering and forms of data analysis, etc., in planning and executing a research study. Similarly, Somekh and Lewin (2005) link methodology to rules followed in an inquiry.

## 3.1 Study Area

This study was conducted in Birim Central municipality; Oda in the Eastern Region. The population is about ten thousand. Farming and mining are the major economic activities in the municipality. There are eleven SHS in the municipality which comprised of seven public and four private SHS. The public SHS were Attafuah Senior High Technical School, St. Francis SHS, Salvation Army SHS, Atweaman SHS, Ayirebi SHS, Achiase SHS, Akroso SHS and Akokoaso SHS. The private schools were Akim State SHS, AEA SHS, Kotokuman SHS and All Saint Girls SHS.

## 3.2 Design & Approach

### 3.2.1 Research design

Research design provides the framework for data collection and analysis (Bryman, 2004). A research design refers to a detailed plan of how a research study is to be conducted by operationalizing variables to be measured, selecting samples of interest, and data collection procedure to answer research questions, test hypothesis, test analysis of data (Creswell, 2008).

The study was conducted by using a descriptive survey design. Sproul (1995) states that; a descriptive survey research design collects background information. He recommends the descriptive survey design for research where attitudes, ideas, comments and public opinion on a problem undergo investigation. Further, Bell (1993) says it also aims to obtain information from a representative selection of the population from which the investigator presents the findings as being representative of the population as a whole. Borg and Gal (1989) note that, descriptive survey research design is intended to produce statistical information on aspects of education that interests policy makers and educators. Based on such reasons, the researcher deemed it suitable to use the descriptive survey design for this study; it helps researchers gain insight in generalizing a situation without utilizing the whole population. It is suitable in determining reasons or causes for a study (Bless & Higson, 1995; Mugenda & Mugenda, 1999).

Babbie (1992) adds that a careful reporting methodology of the descriptive survey promotes replication later by other researchers and re-testing the finding. Descriptive survey design does secure situations that identify standards or norms in order to plan the next step (Best & Kahn, 2000).

### 3.2.2 Research approach

Mixed methods concurrent approach was employed to collect data using questionnaires with open and closed-ended items. Quantitative data involved the collection of numerical data in order to explain, predict and or control phenomena of interest: data analysis was mainly statistical. Qualitative technique involved the collection of extensive narrative data in order to gain insights into phenomena of interests: data analysis included the coding of the data and production. It studies the phenomena as element/respondents are in their natural setting (Gay, 1996: Locke, Silverman & Spirduso, 2004). To achieve this, the researcher employed different methodologies and data collection strategies. The approach chosen for the study was suitable because it helped the researcher to:

1. describe the type of facilities and equipment used in the teaching and learning of SHS biology in the Birim Central Municipality.
2. describe challenges faced by biology teachers in using practical activities during teaching and learning in the Birim Central Municipality.
3. suggest strategies that could be adopted to help solve the challenges faced by biology teachers in the area.

### 3.3 Population, Sample & Sampling Procedures/Technique

#### 3.3.1 Population

Population refers to the individuals or elements on whom/which the researcher intends to generalize his/her findings (Orodho, 2008). Thus, a population is a group of elements or causes, whether individuals, objects or events, that conform to specific criteria and on which research results are intended to generalized (McMillan & Schumacher, 2001). The target population for this study was all teachers and SHS biology students in five public SHSs (Attafuah Secondary Technical School, St. Francis SHS, Achiase SHS, Salvation Army SHS, and Atweaman SHS) all within the Birim Central municipality. Thus, the target population size for the study was four hundred and fifty; fifty biology teachers (28 males and 22 females) and four hundred biology students (273 boys and 127 girls) in the five SHSs. In the context of this study, the Attafuah Secondary Technical School, Salvation Army SHS and Atweaman SHS in the Municipality, were classified as urban schools; while St. Francis SHS and Achiase SHS were classified as rural schools. Birim Central Municipality was purposively selected because no study of this kind had been carried out in the municipality. Additionally, the municipality was due to its varied composition of urban and rural settings.

### 3.3.2 Sample size

Treatment of entire target population, in research, is mostly impractical. Purposive convenient and proportional sampling procedures were employed to select one hundred and twenty-five (125) participants for the study. The 125 sample size comprised of twenty-five biology teachers and hundred biology students. Gay and Airasian (2003) state that a sample size of 10% to 20% of the target population is often used in descriptive survey design. Based on this, 20% of the target population giving a sample size 125 was used for this study. Thus, 10% sample size for biology teacher and 80% for biology teachers.

### 3.3.3 Sampling procedure

Purposive sampling procedure was employed to select all the participants for the study. The power of purposive sampling is to select information-rich participants (Patton, 1990). For purposive sampling to be effective, participants must be identified based on qualifications and characteristics that are of relevance to the study. Similarly, Gay and Airasian (2003) define purposive sampling as one which involves selecting a sample based on experiences or knowledge of the group to be sampled. Participants were purposively selected for this study because of their positions (characteristics) and expertise in the topic under investigation.

Proportional sampling procedure was used to select hundred (100) biology students (63 boys and 37 girls) from all the five public SHS in the Birim Central Municipality.

The primary purpose of this sampling process was to ensure that each area is represented by an adequate sample size as part of the total population (Rea& Parker, 2005). Thus, this procedure ensured that both urban and rural public SHS as well as boys and girls were adequately represented in the study. Finally, convenience sampling procedure was used to select twenty-five (25) biology teachers (16 males and 9 females). So in all, 125 questionnaires were administered to participants: 100 biology students and 25 biology teachers.

### 3.4 Instrumentation

Questionnaire with open and close-ended items was the instrument used to collect data in the study. The questionnaire was developed by the researcher in consultation with her supervisor. The questionnaire was structured in accordance with the research objectives, so as to achieve the anticipated results. Questionnaire was selected because almost all the participants are literate and could read and respond to the items on the instrument. More so, questionnaire was answered more easily and quickly by participants as compared to other instruments (Ary, Jacobs, Razavieh & Sorensen, 2006). Moreover, due to the large number of participants, interviewing all of them was unlikely; hence, the use of questionnaire.

The questionnaire comprised of three sections: Section A, B and C. Section ‘A’ comprised of 7 items on the questionnaire for students and 9 items on the questionnaire for teachers. The section A collected data on the background information of participants (school, gender, age, class, academic qualification, teaching experience). Section ‘B’ comprised of 17 items on a 4-points Likert scale on the questionnaire for both teachers and students.

This section (B) focused on the use of practical activities and its impact on academic performance of biology students in the Birim Central Municipality. Finally, Section 'C' composed of: one (1) item on challenges faced by biology teachers in the use of practical activities; and one (1) item on ways to overcome those challenges. Participants were allowed 35 minutes to respond to the questionnaires. Participants were expected to use 4-points Likert scale to answer the items in Section 'B' and were weighed as follows: Strong disagree, disagree, agree and strongly agree.

Besides, open-ended items (Section 'C') were used to supplement the close-ended items. This aspect of the questionnaire was treated as qualitative.

### 3.4.1 Validity of the research instrument

Validity is the ability of a research instrument to measure exactly what is supposed to measure (Ngman-Wara, 2003). The instrument used in this study was taken through face and content validation.

Face validation was established by the researcher's colleagues. Content validity was established by giving the questionnaire to the researcher's supervisor who was expert in the field of study. The supervisor compared the items on the questionnaire to the research questions in order to determine whether the instrument actually measures what it is supposed to measure. Comments and suggestions from the supervisor on the instrument were effected before it was administered to the participants.

### 3.4.2 Reliability of the instrument

Reliability is the consistency of measurement, or the degree to which an instrument measures the same way each time it is used under the same conditions with the same subjects (Ngman-Wara, 2003). To test the reliability of the instrument used in this study, pre-test was conducted using the instrument students in Oda SHS in the Birim Central Municipality. Oda SHS was selected because it has similar features as compared to the study areas. The questionnaire was pre-tested on fifty (50) biology students and fifteen (15) biology teachers. The main statistical measure to determine reliability of the questionnaire was the use of Cronbach's alpha coefficient estimate. Thus, Cronbach's alpha reliability coefficient was calculated at of 0.81 after the pilot study and 0.87 for the main study; hence, the instrument was reliable since according to Amin (2005), Cronbach's alpha value of 0.7 and above is considered reliable. Cronbach's alpha was selected because according to Amin (2005) it is a much more general form of internal consistency estimate than the other forms of test reliability estimate such as split-half and test re-test.

### 3.5 Data Collection Procedure

An introductory letter from the Science Department, University of Education, Winneba was obtained to facilitate permission from the various authorities (head masters/mistresses, heads of department, teachers and students). Questionnaire was administered personally; hence, helped to clarify some issues to participants. Also, it helped to obtain 100% return rate.

### 3.6 Ethical Concerns

Introductory letter from the Science Department of University of Education, Winneba Campus was obtained to seek permission from gate keepers. Also, permission to administer questionnaires was sought from participants. Participants were assured of privacy and confidentiality. For instance, participants were asked not to write their names on the questionnaires. In addition, where there were direct quotes, only the coding numbers were referred to. Finally, all references were duly acknowledged to avoid plagiarism.

### 3.7 Data Analysis

Quantitative data collected was analyzed using descriptive statistic tool such as frequencies and percentages. Statistical Packages for Social Sciences (SPSS) version 21 was employed to support in the interpretation of quantitative data. The analyzed data (quantitative data) was presented in tables. On the other hand, the qualitative data (open-ended items) was analyzed using content analysis. In doing this, personal and identification details were left out to ensure the anonymity of the participants.

### 3.8 Chapter Summary

This study was conducted in Oda in the Birim Central municipality. Descriptive survey design using mixed methods concurrent approach was employed to collect data. One hundred and twenty-five (125) participants were chosen for the study; 25 biology teachers and 100 biology students. They were selected through purposive, convenient, and proportional sampling techniques.

Instrument for data collection were questionnaires. Descriptive statistic tool (frequencies, percentages, means and standard deviations) was used to analyze the quantitative data whereas content analysis was used to analyze the qualitative data (open-ended items). Finally, ethical concerns and chapter summary were discussed in this chapter. The next chapter focuses on analysis and presentation of data.

# CHAPTER FOUR

# RESULTS AND DISCUSSION

## 4.0 Overview

The purpose of this study was to investigate the impact of practical activities on the academic performance of biology students in Birim Central Municipality, Eastern Region.This chapter deals with the presentation and discussion of results which were discussed under three sections; section one presented the background information of participants, section two comprised of results of the qualitative data (open-ended questions), and section three dealt with discussion of the results in relating to research questions as well as the discussion of findings.

## Section One

## 4.1 Results on the Background Information of Participants

This section dealt with the demographic data of participants which includes participants' location of school, type of school, age, form, academic qualification, teaching experience, number of years spent at the school. These variables were chosen in order to determine whether or not participants would report the same kind of information based on the same variables about the impact of practical activities on the academic performance of biology students in Birim Central Municipality. Table 2 presents the demographic data of participants in the study.

**Table 2: Results on biology students' demographic data**

| | | Frequency | Percent |
|---|---|---|---|
| Location of School | Urban | 60 | 60 |
| | Rural | 40 | 40 |
| Type of School | Boys | - | - |
| | Girls | - | - |
| | Mixed | 100 | 100 |
| Gender | Male | 63 | 63 |
| | Female | 37 | 37 |
| Age (in years) | 10-12 | - | - |
| | 13-14 | 18 | 18 |
| | 15-17 | 58 | 58 |
| | 18 and above | 24 | 24 |
| Class | SHS One | 35 | 35 |
| | SHS Two | 65 | 65 |
| Number on Roll | 30-40 | 37 | 37 |
| | 41-50 | 28 | 28 |
| | 51-60 | 14 | 14 |
| | 61-70 | 2 | 2 |
| | 71 and above | 19 | 19 |
| Number of biology periods per week | 1-3 | - | - |
| | 4-5 | 100 | 100 |

Total Number of Students =100

From Table 2, majority of the students were from the urban schools (60, representing 60%) as compared to those from the rural schools (40, representing 40%). However, both urban and rural schools were considered during the selection of schools; hence, findings would be more concrete as compared to using only urban schools or rural schools. In Table 2, all the students used for the study were from mixed schools (100, representing 100%) with no student from either boys or girls school (0, representing 0%).

Again, Table 2 shows that, there were more boys (63, representing 63%) than girls (37, representing 37%). But the researcher was not bias in the selection of only boys or girls for the study. It could be seen from the data from Table 2 that, most of the students were between the ages of 15-17 years (58, representing 58%), followed by 18 years and above (24, representing 24%), 13-14 years (18, representing 18%) with no student between 10-12 years (0, representing 0%). It is clear from the data on age that, all the students were adolescents and issue concerning them so be of great priority to all educational stakeholders since they are the future leaders of this country.

According to Table 2, there were more students in SHS 2 (65, representing 65%) than in SHS 1 (35, representing 35%). This implies that, even though there are differences in terms of number, both SHS 1 and 2 students were considered in the selection of student participants. Most importantly, if measures are not put in place to help solve the problems faced by biology teachers in the use of practical activities during lessons, the SHS 2 students would soon get to SHS 3 without preparing adequately for the practical aspect of their final exams; hence, affecting their academic performance negatively during their final exams.

As indicated Table 2, most of the classes sampled had 30-40 students (37, representing 37%), followed by 41-50 students in a class (28, representing 28%), 71 and above (19, representing 19%), 51-60 (14, representing 14%) and 61-70 (2, representing 2%). Even though most of the classes fall within the average, school management should consider reducing the size since most of the schools do not have the apparatus to handle such large classes. Regarding the number of Biology periods per week, Table 2 shows that, all the students have five (5) periods per week which is the approved number of periods per week for biology. Next is the result on teachers' background information for the study.

**Table 3: Teachers' demographic data**

| | | Frequency | Percent |
|---|---|---|---|
| Location of School | Urban | 15 | 60 |
| | Rural | 10 | 40 |
| Type of School | Boys | - | - |
| | Girls | - | - |
| | Mixed | 25 | 100 |
| Gender | Male | 16 | 16 |
| | Female | 9 | 9 |
| Age (in years) | 20 and below | - | - |
| | 21-30 | 7 | 28 |
| | 31-40 | 10 | 40 |
| | 41-50 | 8 | 32 |
| | 51 and above | - | - |
| Academic Qualification | O/A Level | - | - |
| | Certificate 'A' | - | - |
| | Diploma | - | - |
| | 1st Degree | 18 | 72 |
| | Masters' and above | 7 | 28 |
| Major subject area in qualification | Chemistry | 5 | 20 |
| | Physics | 9 | 36 |
| | Biology | 11 | 44 |
| | Agriculture | - | - |
| Teaching Experience | 1-5 years | - | - |
| | 6-10 years | 3 | 12 |
| | 11-15 years | 7 | 28 |
| | 16-20 years | 10 | 40 |
| | 21-25 years | 5 | 20 |
| | 26-30 years | - | - |
| | 31 years and above | - | - |
| Number of Biology periods per week | 1-3 | - | - |
| | 4-5 | 25 | 100 |
| Average Number of students in a class | 30-40 | 5 | 20 |
| | 41-50 | 7 | 28 |
| | 51-60 | 8 | 32 |
| | 61-70 | 3 | 12 |
| | 71 and above | 2 | 8 |

Total Number of Biology Teacher = 25

From Table 3, majority of the teachers were from the urban schools (60, representing 60%) as compared to those from the rural schools (40, representing 40%). Again, Table 3 indicates that, all the teachers were from mixed schools (100, representing 100%) with no student from either boys' or girls' school (0, representing 0%). These results therefore confirm that of the students. Also, Table 3 shows that, there were more male teachers (16, representing 64%) than females (9, representing 36%). Majority of the teachers were between the ages of 31-40 years (10, representing 40%), followed by 41-50 years (8 representing 32%), 21-30 years (7 representing 28%) and none of the teachers was above age 51 (0 representing 0%). This implies that, all the teachers were in their youthful stage and were likely to have a cordial relationship with the students since most of them too were adolescent. This, in a way, would build good teacher-students relation during teaching and learning in the classroom. However, the data also suggest that, because all the teachers were young there is the likelihood that they may assume they are energetic and would prefer lecture method instead of using practical activities in teaching biology lessons.

From Table 3, most of the teachers were first degree holders (18, representing 72%) as compared to masters' degree and above (7, representing 28%). This result implies that, teachers obtained the pre-requisite (needed) educational background for them to teach at the SHS level. This academic qualification is therefore likely to have an impact on their teaching methodology or style. From Table 3, most of the teachers have majored in Biology (11, representing 44%), followed by Physics (9, representing 36%) and Chemistry (5, representing 20%). Interestingly, the data suggest that, even though all the teachers were teaching biology, more than half of them did not major in biology. There is therefore the likelihood that, it would have adverse effects on the subject matter (content) of these teachers who did not major in biology.

Thus, even though all the teachers had at least four years of tertiary education, it can be inferred from Table 3 that majority of SHS biology teachers have their qualifications outside biology. What it means is that most of the biology teachers are not trained as professional teachers in that field but have been recruited by Ghana

Education Service (GES) to teach, a phenomenon commonly practiced in Ghana. That is, university graduates without qualifications in a particular subject area were recruited to teach in SHS and are classified as "qualified" teachers. Although, recruited teachers may have the content knowledge and competence in subject matter, same cannot be said of their pedagogical knowledge and relevant skill-set to promote effective delivery of instruction.

As noted by Darling-Hammond (2000), McDermott and Shaffer (2000) and Orleans (2007), to produce larger student achievement gains, one must be competent in both subject matter (content) and pedagogical skills. This finding is therefore a wakeup call on the Ministry of Education Ghana as well as all head masters and mistresses of the SHSs to ensure that, teachers teach their areas of specification. Moreover, this finding agrees with that of van Driel, Beijaard and Verloop (2001) whose study findings indicated that, the teachers' knowledge base strongly influences all aspects of teaching like preparation, planning and decision making regarding the choice of content to be learnt.

From Table 3, most of the teachers with 16-20 years teaching experience (10, representing 40%), followed by 11-15 years (7, representing 28%), 21-25 years (5, representing 20%) and 6-10 years (3, representing 12%). This result suggests that teachers have advanced in terms of teaching experience and were likely to improve upon their teaching strategies as compared to those who have not been in the service for long (newly posted teachers). The data on teachers' years of teaching experience in relation to the age distribution as shown in Table 3 also suggest that most of the SHS may not have experienced biology teachers at post. It pre-supposes that some of the teachers teach for few years and leave the classroom for other jobs, perhaps more lucrative jobs other than teaching. Though in some countries teachers are among the highly paid workers the situation in Ghana is the exact opposite. It is therefore not surprising that some teachers nowadays undertake courses outside the education sector since is a requirement by many of the Non-Governmental Organizations (NGOs) who are noted of paying 'good' salaries to their employees.

These findings confirm teacher quality as one and most influential factor on students' academic performance and many a time, academic preparation of teachers, type of certificate, professional learning and years of teaching experience are taken as indicators of teacher quality (Darling-Hammond, 2000; Darling-Hammond, Berry & Thoreson, 2001; Goldhaber & Anthony, 2003). In this study, only academic qualification (types of certificate) and teaching experience of the teachers were discussed.

From Table 3, all the teachers have five (5) periods per week which is the approved number of periods per week for teaching biology at the SHS level. Finally, Table 3 indicate that, majority of the teachers handle 51-60 students in a class (8, representing 32%), followed by 41-50 students (7, representing 28%), 30-40 students (5, representing 20%), 61-70 students (3, representing 12%), and 71 and above (2, representing 8%). This result implies that, even though most of the teachers handle average number of students in a class, due to lack of apparatus in most of the schools, there is the likelihood that, most of the teachers would find it difficult to handle students when it comes to practical activities.

**Section Two**

## 4.2 Results of the Qualitative Data (Open-Ended Items)

To better understand the topic under investigation, open-ended questions were used to further probe why participants choose a particular response in the close ended items. To protect the identity of the participants who responded to the questionnaires, they were represented by 'SP' and 'TP' which means 'student participants' and 'teacher participants' respectively. Next is what students and teachers wrote in relation to the choice they made.

### 4.3.1 Challenges faced by biology teacher in using practical activities during biology lessons

Commenting on some of the challenges faced by Biology teacher in using practical activities during Biology lessons, this was what one student wrote:

> *My school lacks biology equipment such as microscope; hence, makes it very difficult for biology teachers to use practical activities during teaching and learning [SP 45].*

Similarly, another student wrote:

> *We have only one laboratory for all our electives and even that it is too small to contain all the students at a go. Therefore, makes it difficult for biology teacher to use practical activities during biology lessons [SP 15].*

This is not different from what another student wrote:

> *Our class size is far more than the apparatus at the laboratory and this makes it very difficult for biology teachers to use practical activities during biology lessons in this school [SP 95].*

Again, commenting on the same issue, this is what another student wrote:

> *I think biology apparatus are very expensive and the school cannot afford them. This compels biology teachers to teach without using practical activities in our school [SP 39].*

Notwithstanding the above, one student also wrote:

> *I think some of our teachers lack the knowledge and skills on how to use the practical activities and therefore finds it difficult to teach us using that method[SP 67].*

These comments were not different from what some of the biology teachers wrote. For instance, one teacher wrote:

> *We lack the necessary equipment in this school to teach practical activities and this situation disturbs us a lot[TP 7].*

Another teacher participant wrote:

> *Sometimes I wish to seek for transfer because I don't feel happy teaching practical lessons without apparatus. This is because, management are not ready to buy Biology apparatus for us with the reason that the government has not release money as promised[TP 15].*

Similarly, one teacher wrote:

> *I really understand the importance of teaching using practical activities but the school has no laboratory for that. Therefore, we teach most of the lessons through lecture method which should not have been so[TP 15].*

Comments from these participants suggest that, challenges faced by biology teachers in the use of practical activities range from lack of equipment, inadequate laboratory, large class size, high cost of biology equipment through to incompetency on the part of some biology teachers. These comments therefore suggest that, to help improve the performance of students in biology, school management, parents, teachers and the government should consider how best to overcome these challenges. When these challenges are solved, there is the likelihood that, students' performance in biology would be improved.

In conclusion, school management and the government should find a permanent solution to these challenges.

### 4.3.2 How to address challenges faced by biology teacher in using practical activities

In relation to the above question, this is what some of the students wrote:

> *A well-built and spacious laboratory by the government for conducting experiment would help overcome the challenge biology teachers face in using practical activities during teaching and learning[SP 54].*

Another student wrote:

> *School authorities should provide the needed apparatus to for biology teachers. When this is done it will help overcome the challenge of lack of apparatus for teaching biology using practical activities.[SP 6]*

Again, one student wrote:

> *If the school management can reconsider the class size for the science programs, it would help reduce the challenge of inadequate apparatus for teaching biology in this school[SP 28].*

Similarly, this is what some of the teachers wrote:

> *We are all aware that biology apparatus are very expensive but if the school authorities can buy them one after the other it would help improve teaching and learning in this school[TP 18].*

Another teacher also wrote:

> *If the board of governors together with the PTA can find a lasting solution to the challenge of non-availability of science laboratory in this school, it will go a long way to improve teaching and learning using practical activities[TP 12].*

One other teacher commenting on the same issue wrote:

> *Can you imagine I am handling about 65 biology students with only five apparatus (microscope) so how do I teach using practical activities?*
> *If management can reduce the class size to say 30 during admissions, it will help reduce the challenge of student apparatus ratio[TP 15].*

Another teacher wrote:

> *The size of the laboratory is too small to contain students during biology practical. Also, we don't have sufficient apparatus when performing practical in biology[TP 25].*

It could be deduced from the above point raised by both biology teachers and students that, there is a cause to teachers' inability to use practical activities in teaching biology at the SHS level.

In summary, the government, parents and school management should device a mechanism to help solve these challenges.

**Section Three**

**4.3 Results According to the Research Questions**

This part dealt with the results of the study in accordance with the research questions. Five research questions were asked in this study.

**Research Question 1**

The first research question was: "What kinds of teaching methods do biology teachers in the Birim Central Municipality use during teaching?" Items 1-5 under section 'B' of the questionnaire for students were used to answer this question and the results are shown in Table 4.

**Table 4: Result by students on kind of teaching method used by biology teacher**

| | Strongly Disagree | | Disagree | | Agree | | Strongly Agree | |
|---|---|---|---|---|---|---|---|---|
| | f | % | f | % | f | % | f | % |
| Biology teacher serves as a facilitator during biology lessons | 47 | 47 | 40 | 40 | 10 | 10 | 3 | 3 |
| Students do not use their own initiative during biology lessons | 6 | 6 | 10 | 10 | 35 | 35 | 49 | 49 |
| Teacher first demonstrates and afterwards students follow suit during biology lessons | 48 | 48 | 23 | 23 | 10 | 10 | 15 | 15 |
| Teacher dominates throughout the lesson | 5 | 5 | 10 | 10 | 38 | 38 | 47 | 47 |
| Teacher uses practical activities during biology lessons | 50 | 50 | 14 | 14 | 33 | 33 | 3 | 3 |

Total Number of Students=100

From Table 4, half of the students (50, representing 50%) were against the statement that teachers use practical activities during biology lessons. Again, almost half of the students (47, representing 47%) were against the assertion that biology teacher serves as a facilitator during biology lessons. Notwithstanding the above, about half of the students (48, representing 48%) were not in agreement with the statement that teachers first demonstrate and afterwards students follow suit during biology lessons. However, students (3, representing 3%) were in agreement with the statement that, teachers use practical activities during biology lessons. This implies that, there is the likelihood that, most of the teachers in the municipality use the lecture (talk-and-chalk) method instead of the inquiry (learner-centered) approach when teaching lessons in biology.

Again, items 1-5 under section 'B' of the questionnaire for teachers were also used to answer research question one and the results are shown in Table 5.

**Table 5: Result by teachers on kind of teaching method used by during biology lessons**

| | Strongly Disagree | | Disagree | | Agree | | Strongly Agree | |
|---|---|---|---|---|---|---|---|---|
| | f | % | f | % | f | % | f | % |
| I serve as a facilitator during biology lessons | 3 | 12 | 5 | 20 | 10 | 40 | 7 | 28 |
| I don't allow students to use their own initiative during biology lessons | 6 | 24 | 10 | 40 | 5 | 20 | 4 | 16 |
| I first demonstrate and afterwards students follow suit during biology lessons | 9 | 36 | 10 | 40 | 2 | 8 | 4 | 16 |
| I dominate throughout the lesson | 1 | 4 | 4 | 16 | 3 | 12 | 17 | 68 |
| I use practical activities during biology lessons | 5 | 20 | 3 | 12 | 2 | 8 | 15 | 60 |

Total Number of Teachers=25

From Table 5, most of the teachers (15, representing 60%) were in agreement with the statement that, teachers use practical activities during practical lessons. Again, Table 5 indicates that, more than two-thirds of the teachers (9, representing 36%) were against the assertion that, teachers first demonstrate and afterwards students follow suit during biology lessons. The result implies that, most of the teachers were of the view that, they use the practical activities as compared to the lecture method in teaching biology lessons. But, this result contradicts with that of the students. The reason could have been that, some teachers did not want to report their weaknesses in their teaching practice.

It could therefore be concluded that, majority of the teachers sampled do not use practical activities during teaching and learning of biology at the Birim Central Municipality.

Findings of this study agree with that of Chonjo, Osaki, Possi and Mrutu (1996). Their study findings revealed that traditional teacher-centered lecture (chalk and talk) approach, which emphasizes the transfer of knowledge and skills and rewards memorization, is the predominant teaching format used in secondary schools in Tanzania. Their findings further revealed that, in using this approach, teachers talk most of the time, while students jot down notes mainly for the purpose of passing exams.

This method does not allow much room for critical analysis of issues but it makes students to duplicate the notes given back to the teacher. Also, findings of this study confirm that of Osaki (2000) which revealed that most teachers used transmission (chalk and talk) rather than interactive, learner-centered pedagogy. Likewise, findings of teacher - initiated, and dominated teacher-student interaction and lecture method as major methods of teaching agree with Ajaja (2009) who made similar findings in different public schools in Delta State, Nigeria.

Furthermore, findings as indicated in Table 4, show that pattern of interaction in most biology classrooms is the teacher initiated and dominated teacher-student interaction. This is not in consonant with international standards which recommend that teachers of science plan inquiry-based programs for their students and should also interact with students to focus and support their inquiries, recognize individual differences and provide opportunities for all students to learn (Bybee, Carlson-Powell& Trowbridge, 2008; Centre for Inspired Teaching, 2008; Bencze, Alsop& Bowen, 2009). The findings also fall short to the recommendation of teaching for effective learning (learning with understanding) where students take responsibility of their own learning through active construction and reconstruction of their own meanings for concepts and phenomena (Brass, Gunstone & Fensham, 2003; Borich, 2007).

**Research Question 2**

"What is the state of facilities (science laboratory, equipment etc.) available to biology teachers for teaching of biology in the Birim Central Municipality" was the second research question framed to guide the study. Items 6-10 under section 'B' of the questionnaire for students were used to answer this question and the results are shown in Table 6.

**Table 6: Result by students on the state of facilities used in during biology lessons**

| | Good | | Satisfactory | | Poor | |
|---|---|---|---|---|---|---|
| | f | % | f | % | f | % |
| Sufficient laboratory facilities in this school | 20 | 20 | 28 | 28 | 52 | 52 |
| State of repair of laboratory facilities | 12 | 12 | 5 | 5 | 83 | 83 |
| Amount of equipment for experiments | 7 | 7 | 13 | 13 | 80 | 80 |
| State of repair of laboratory equipment | - | - | 14 | 14 | 86 | 86 |
| Quality of the student textbook(s) | 3 | 3 | 47 | 47 | 50 | 50 |

Total Number of Students=100

From Table 6, most of students (83, representing 83%) were of the view that repair of laboratory facilities in their schools were in a poor state. Similarly, 52 (representing

52%) of students were of the view that laboratory facilities in their schools were in a poor state. This result suggests that, even though some schools have the laboratories but they were not in good shape; hence, they would not be in a position to serve the purpose for which they were built.

Similarly, items 6-10 under section 'B' of the questionnaire for teachers were used to answer research question two and the results are shown in Table 7.

**Table 7: Result by teachers on the state of facilities used in during biology lessons**

| | Good | | Satisfactory | | Poor | |
|---|---|---|---|---|---|---|
| | f | % | F | % | f | % |
| Sufficient laboratory facilities in this school | 6 | 24 | 5 | 20 | 14 | 56 |
| State of repair of laboratory facilities | 2 | 8 | 6 | 24 | 17 | 68 |
| Amount of equipment for experiments | 7 | 28 | 5 | 20 | 13 | 52 |
| State of repair of laboratory equipment | - | - | 5 | 20 | 20 | 80 |
| Quality of the student textbook(s) | 8 | 32 | 7 | 28 | 10 | 40 |

Total Number of teachers =25

From Table 7, most of the teachers (20, representing 80%) were of the view that, state of repair of laboratory equipment was poor. Likewise, the state of laboratory facilities in the schools was poor (17, representing 68%). But, only few of the teachers (6, representing 24%) were of the view that laboratory facilities in the schools was good. This result suggests that, biology teachers in the Birim Central municipality cannot perform any meaningful practical activities as a result of the poor state of the laboratory facilities and equipment.

Findings of this study tally with that of Akinola's (2006) study carried out in Nigeria, where findings revealed that performance in science subjects including biology was very poor in the secondary schools. The author reported that, among factors that contributed to this poor performance, were inadequate learning facilities in the secondary schools including science equipment and laboratories among others.

Similarly, findings of this study correspond with that of Dzana (2012). Among other factors were poor state of laboratory facilities, lack of science equipment, and lack of quality text books, were the main causes of poor performance of students (Dzana (2012).

**Research Question 3**

The third research question was: "What effects do practical activities have on the academic performance of biology students in the Birim Central Municipality?" Items 11-16 under section 'B' of the questionnaire for students were used to answer this question and the results are shown in Table 8.

**Table 8: Result by students on effects of practical activities on their academic performance in biology, on the students' questionnaire**

| | Strongly Disagree | | Disagree | | Agree | | Strongly Agree | |
|---|---|---|---|---|---|---|---|---|
| | f | % | f | % | f | % | f | % |
| High performance of students is as a result of practical activities during biology lessons | 45 | 45 | 38 | 38 | 10 | 10 | 7 | 7 |
| Students perform far below average as a result of lack of practical activities during biology lessons | 12 | 12 | 5 | 5 | 41 | 41 | 42 | 42 |
| Some students are not attracted to study biology due to lack of practical activities | 11 | 11 | 6 | 6 | 34 | 34 | 49 | 49 |
| Students lack understanding in biology due to lack of practical activities | 7 | 7 | 12 | 12 | 28 | 28 | 53 | 53 |
| Students can apply knowledge and skills gained in biology with the help of practical activities | 9 | 9 | 8 | 8 | 39 | 39 | 44 | 44 |
| Students can retain knowledge and skills gained in biology for long with the help of practical activities | 46 | 46 | 40 | 40 | 8 | 8 | 6 | 6 |

Total Number of Students=100

From Table 8, most of the students (53, representing 53%)were in agreement with the statement that, the data show that, students lack understanding in biology due to lack of practical activities. Moreover, almost half of the students (46, representing 46%)

were not in favor with the statement that, students can retain knowledge and skills gained in biology for long with the help of practical activities. Similarly, students were in not agreement with the statement that, high performance of students is as a result of practical activities during biology lessons (45, representing 45%). This result suggests that, if biology students' academic performance was high, then, it was as a result of other factors apart from the use of practical activities during teaching and learning.

Furthermore, items 11-16 on questionnaire for teachers were used to answer this question and the results are shown in Table 9.

**Table 9: Result by teachers on effects of practical activities on academic performance of students in biology in teachers' questionnaire**

| | Strongly Disagree | | Disagree | | Agree | | Strongly Agree | |
|---|---|---|---|---|---|---|---|---|
| | f | % | f | % | f | % | f | % |
| High performance of students as a result of practical activities during biology lessons | 12 | 48 | 6 | 24 | 4 | 16 | 3 | 12 |
| Students perform far below average as a result of lack of practical activities during biology lessons | 10 | 40 | 3 | 12 | 7 | 28 | 5 | 20 |
| Some students are not attracted to study biology due to lack of practical activities | - | - | 2 | 8 | 6 | 24 | 17 | 68 |
| Students lack understanding in biology due to lack of practical activities | - | - | 2 | 8 | 9 | 36 | 14 | 56 |
| Students can apply knowledge and skills gained in biology with the help of practical activities | 9 | 36 | 8 | 32 | 3 | 12 | 5 | 20 |
| Students can retain knowledge and skills gained in biology for long with the help of practical activities | 10 | 40 | 8 | 32 | 2 | 8 | 5 | 20 |

Total Number of Teachers=25

From Table 9, most of the teachers (17, representing 68%) were in agreement with the statement that, some students are not attracted to study biology due to lack of practical activities, followed by students lack understanding in biology due to lack of practical activities (14, representing 56%). Few of the teachers (5, representing 20%) were in agreement with the statement that students can retain knowledge and skills gained in biology for long with the help of practical activities. This result implies that, inability of some biology teachers to use practical activities during teaching have negative effects of students' academic performance in biology in the Birim Central Municipality.

Findings of this study confirm that of Wabuke (2009) which revealed that inability of biology teachers to carry out the practical effectively contributed significantly to students' poor performance in biology in Kenya. Again, this finding support previous studies in Nigeria by Ajewole (1994), Okebukola (1997), Ogunleye (1999), Folaranmi (2002) and Olaleye (2002) which indicated that inadequate laboratory apparatus or equipment, and lack of provision (in many homes) for the educational needs of students in science are impediments to effective science education. Also, modern quality resources including computers and internet access are lacking for improving school administration, teacher record-keeping and for teaching and learning. High performance of biology students cannot therefore be achieved in a school that lacks laboratory apparatus and equipment and other resources that could facilitate teaching and learning of science. This study shows that for biology students to improve upon their performance, additional funds are required to build more well-furnished laboratories for biology teachers to effectively involve learners in small group practical activity work in the laboratories rather than in general classrooms.

**Research Question 4**

The fourth research question was "What challenges do biology teachers face in using practical activities during the teaching of biology in the Birim Central Municipality?" Item 17 under section 'B' of the questionnaire for both teachers and students was used to answer this question and the results are shown below:

Commenting on some of the challenges faced by biology teacher in using practical activities during biology lessons, this was what one student wrote:

> *My school lacks biology equipment such as microscope; hence, makes it very difficult for biology teachers to use practical activities during teaching and learning [SP 45].*

Similarly, another student wrote:

> *We have only one laboratory for all our electives and even that it is too small to contain all the students at a goal. Therefore, makes it difficult for biology teacher to use practical activities during biology lessons [SP 15].*

This is not different from what another student wrote:

> *Our class size is far more than the apparatus at the laboratory and this makes it very difficult for biology teachers to use practical activities during biology lessons in this school [SP 95].*

One other teacher commented on the same issue:

> *Can you imagine I am handling about 65 biology students with only five microscopes, so how do I teach using practical activities? If management can reduce the class size to about 30 during admissions, it will help reduce the challenge of student to apparatus ratio[TP 15].*

Likewise, one teacher wrote:

> *The size of the laboratory is too small to contain students during biology practical sessions. Also, we don't have sufficient apparatus when performing practical in biology[TP 25].*

Comments from biology teachers and students suggest that, biology teachers were unable to use practical activities in their lessons as a result of small laboratory size, inadequate biology laboratory apparatus and large class size. This implies that, if biology teachers could use practical activities during teaching and learning, all other things being equal, spacious laboratory should be provided, class size should be reduced and more biology apparatus should be purchased. In that way, biology teachers would be in a better position to use practical activities during biology lessons.

**Research Question 5**

The fifth research question was "What strategies could be adopted to help solve the challenges faced by biology teachers in using practical activities during teaching?" Item 18 under section 'B' of the questionnaire for both teachers and students was used to answer this question and the results are shown below:

In relation to the above question, this is what some of the students wrote:

> *A well-built and spacious laboratory by the government for conducting experiment would help overcome the challenge biology teachers face in using practical activities during biology teaching and learning[SP 54].*
>
> *School authorities should provide the needed apparatus to for biology teachers. When this is done, it will help overcome the challenge of lack of apparatus for teaching biology using practical activities[SP 6].*
>
> *If the school management can reconsider the class size for the science programs, it would help reduce the challenge of inadequate apparatus for teaching biology in this school[SP 28].*

Similarly, this is what some of the teachers wrote:

> *We are all aware that biology apparatus are very expensive but if the school authorities can buy them one after the other it would help improve teaching and learning of biology in this school[TP 18].*

*If the board of governors together with the PTA can find a lasting solution to the challenge of non-availability of science laboratory in this school, it will go a long way to improve teaching and learning using practical activities [TP 12].*

*Can you imagine I am handling about 65 biology students with only five microscope, so how do I teach using practical activities? If management can reduce the class size to about 30 during admissions, it will help reduce the challenge of student apparatus ratio[TP 15].*

It is clear from the above comments from both biology teachers and students that, it is not deliberate that biology teachers do not want to use practical activities during lessons but rather they were faced with some challenges. However, if these challenges are well addressed, there is the zeal that biology teachers would adopt practical activities in teaching and learning of biology in schools.

To sum it up, this chapter dealt with the analysis of data and presentation of results which was discussed under three sections; section one (background information of participants), section two (results of the qualitative data [open-ended questions]) and section three (results according to research questions) with discussion of findings. Chapter five deals with the findings, conclusion and recommendations.

# CHAPTER FIVE

# SUMMARY, CONCLUSIONS, RECOMMENDATIONS AND SUGGESTIONS FOR FUTURE STUDIES

## 5.0 Overview

The purpose of this study was to investigate the impact of practical activities on the academic performance of biology students in Birim Central municipality. This chapter focused on the summary, conclusion, recommendations and suggestions for future studies.

## 5.1 Summary of the Study

The summary of the study indicate that students' poor performance in biology in Birim Central municipality can be attributed to a number of reasons. First and foremost, some of the biology teachers do not have academic qualification and/or certificate pertaining to biology. What this means is that these teachers may lack the pedagogical knowledge and unfamiliar with the teacher actions that support and promote student learning.

Second, classroom interaction–the disposition of teachers and students during instruction dialogue, seemed to be mostly teacher-centered and tended not to support practical-based teaching and learning which is noted for promoting conceptual change and enhance performance. The traditional way of teaching where teachers decide on what goes on in the classroom has limited space in the 21st century science classrooms, particularly biology. Thus, summary of this study indicate that most biology teachers still hold on to the view that: biology is looked upon as consisting of an unrelated collection of facts, rules, skills and processes to be memorized. This theory explains the underlying assumptions of most biology teachers and further gives us insights on why teachers treat science learning as a passive reception of knowledge and the consequent unreasonable demands placed on learners to be submissive and compliant in the learning process. Thus, most biology teachers talk most of the time, while students jot down notes mainly for the purpose of passing exams. This method does not allow much room for critical analysis of issues but it makes students to duplicate the notes given back to the teacher

Third, even though some SHS in the Birim Central municipality have science laboratories and equipment, they cannot function as expected since they were in poor state. Thus, modern quality resources including multi-purpose laboratory, computers and internet access are lacking for improving teaching and learning. However, high performance in biology cannot therefore be achieved in a classroom environment that lacks enough and modern curriculum materials and resources that could facilitate teaching and learning of Biology.

Fourth, biology teachers were unable to use practical activities in their lessons as a result of small size of the laboratory, inadequate biology apparatus and large class size. Meaning, funds are needed to build more laboratories and classrooms so that class sizes would be reduced for teachers to recognize individual learners, their strengths and weaknesses and also to effectively involve learners in small group practical and activity work in the laboratories rather than in general classrooms.

Fifthly, purchase of biology apparatus, reducing the class size and provision of science laboratory in this school would help reduce address challenges faced by biology teachers in the use of practical activities during teaching and learning.

### 5.2 Conclusions

The findings of this study indicate that there is significant effect of students' performance in biology due to lack of practical activities during teaching and learning.

The study conducted at the Birim Central Municipality in the Eastern Region of Ghana revealed that majority of the teachers were professionals but some did not offer biology as their major area of specialization in the University. To such teachers, practical skills could be improved by organizing regular in-service training for them by stakeholders of Education such as GNAT, NAGRAT, etc.

From the study, it can be into more manageable units. School authorities did not have much interest with provision of science materials and equipment.

According to the respondents (teachers), school authorities only tried to procure science materials during WAEC designated examinations, a situation which is not helping both teachers and students. School authorities should provide science materials and equipment at all times to facilitate learning.

The laboratory in the school lacked laboratory assistance that could help the biology teachers in preparing the laboratory for practical lessons. School authorities should recruit laboratory technicians so that the work load on the teachers will be reduced.

## 5.3 Recommendations

Based on the findings of the study, the following recommendation are proposed

i. Science (Biology) teachers at Birim Central Municipality should be given allowances and regular provision of funds for the purchase of essential materials without gong through the unusual bureaucratic funds.

ii. Headmaster and educational authorities in the Birim Central Municipality should be provided with adequate and relevant teaching and learning materials in the science (Biology) laboratory for students and teachers to use during practical lessons.

iii. The class size of students per class for biology practical lesson should be reduced to small manageable units for an effective practical work.

iv. Regular or periodic in-service training should be organized by the Birim Central Municipality to help the teachers to upgrade their methods of teaching biology using learner-centered approach.

v. Selected Senior High Schools in the Birim Central Municipality with inadequate materials for teaching and learning are advised to make good use of the various science resource centre nearby for practical activities

## 5.4 Suggestions for Future Studies

1. An in-depth study could be done to investigate the teachers' and students' attitude towards the use of practical activities in teaching and learning in public senior high schools in Ghana.
2. Similar studies could be carried out in other regions of Ghana within urban, semi-urban and rural settings to establish whether or not the findings of this study apply to other areas.

3. A thorough study on the impact of practical activities on the academic performance of SHS students in physics or chemistry.

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# APPENDIX A

## UNIVERSITY OF EDUCATION, WINNEBA

## STUDENT'S SURVEY QUESTIONNAIRE

Dear Student,

This is an anonymous questionnaire. Do not write your name, or any other comments that could identify you on this questionnaire. By completing the questionnaire you are consenting to take part in this research. Please, read the information below which explains the purpose of the research.

This questionnaire seeks your opinions and concerns about the use of practical activities in the teaching and learning of Biology at SHS in the Birim Central Municipality. There is no right or wrong answer to each question. Information from this questionnaire will be used to improve the teaching and learning of Biology in SHS in Ghana. The information will be aggregated and summarized for inclusion in research reports. No person or school will be identified in any reports.

**Thank you for your participation in this study**

**SECTION A: Background Information**

Please, respond to all the items below by putting a **tick (√)** in the appropriate space provided.

1. Location of your school: Urban [ ] Rural [ ]
2. Type of School: Boys [ ] Girls [ ] Mixed [ ]
3. Gender: Male [ ] Female [ ]
4. Age(in years): 10-12 years [ ] 13-14 years [ ] 15-17 years [ ] 18 years and above [ ]
5. Class: SHS One [ ] SHS Two [ ]
6. Number of roll:………………………
7. Number of Biology periods per week: ………………………

**SECTION B**

Please, respond to all the items on this page by putting a tick (√) in the appropriate space provided using the following scale: 1=Strongly Disagree, 2= Disagree, 3= Agree and 4= Strongly agree.

| S/No | Items | Strongly Disagree | Disagree | Agree | Strongly Agree |
|---|---|---|---|---|---|
| 1. | My Biology teacher allows us to work on our own while he/she serves as a facilitator during lessons | | | | |
| 2. | My Biology teacher does not permit us to use our own judgment in solving problems during lessons | | | | |
| 3. | My Biology teacher always demonstrates to us before giving us opportunity to work on our own during lessons | | | | |
| 4. | My Biology teacher uses lecture method during lessons | | | | |
| 5. | In Biology class, practical work is used to illustrate concepts that have been introduced | | | | |

Please, respond to all the items on this page by putting a tick (√) in the appropriate space provided using the following scale: 1=Good, 2= Satisfactory, 3= Poor.

| S/No. | Items | Good | Satisfactory | Poor |
|---|---|---|---|---|
| 6. | Sufficient laboratory facilities in this school | | | |
| 7. | State of repair of laboratory facilities | | | |
| 8. | Amount of equipment for experiments | | | |
| 9. | State of repair of laboratory equipment | | | |
| 10. | Quality of the student textbook(s) | | | |

Please, respond to all the items on this page by putting a tick (√) in the appropriate space provided using the following scale: 1=Strongly Disagree, 2= Disagree, 3= Agree and 4= Strongly agree.

| S/No | Items | Strongly Disagree | Disagree | Agree | Strongly Agree |
|---|---|---|---|---|---|
| 11. | My performance in Biology is high as a result of practical activities used during teaching and learning | | | | |
| 12. | My performance is far below average in Biology as a result of lack of practical activities during teaching and learning | | | | |
| 13. | Some students are not attracted to study Biology due to lack of practical activities during teaching and learning | | | | |
| 14. | I lack understanding in Biology due to lack of practical activities during teaching and learning | | | | |
| 15. | I am able to apply knowledge and skills gained in Biology with the help of practical activities during teaching and learning | | | | |
| 16. | I am able to retain knowledge and skills gained in Biology for long with the help of practical activities during teaching and learning | | | | |

**SECTION C**

17. What challenges do you think hinder your Biology teacher in using practical activities in teaching and learning? (Please, list them in order of importance, i.e. 1= most important, 4= less important)

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18. In your own view, how do you think these challenges mentioned in Question 18, can be addressed?

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(ii)……………………………………………………………………………………
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**Thank you for your participation in this study**

# APPENDIX B

## UNIVERSITY OF EDUCATION, WINNEBA

## TEACHER'S SURVEY QUESTIONNAIRE

Dear Teacher,

This is an anonymous questionnaire. Do not write your name, or any other comments that could identify you on this questionnaire. By completing the questionnaire you are consenting to take part in this research. Please, read the information below which explains the purpose of the research.

This questionnaire seeks your opinions and concerns about the use of practical activities in the teaching and learning of Biology at SHS in the Birim Central Municipality. There is no right or wrong answer to each question. Information from this questionnaire will be used to improve the teaching and learning of Biology in SHS in Ghana. The information will be aggregated and summarized for inclusion in research reports. No person or school will be identified in any reports.

**Thank you for your participation in this study**

**SECTION A: Background Information**

Please, respond to all the items below by putting a **tick (√)** in the appropriate space provided.

1. Location of your school: Urban [ ] Rural [ ]
2. Gender: Male [ ] Female [ ]
3. Age range (in years): 20 and below [ ] 21-30 [ ] 31-40 [ ] 41-50 [ ] 51 and above [ ]
4. Academic Qualification: O/A Level [ ] Certificate 'A` [ ] Diploma [ ] 1st Degree[ ] Masters' Degree and above [ ]
5. Major subject area in your Qualification: Chemistry [ ] Physics [ ] Biology [ ]

Agricultural [ ] Others (Please, specify)…………………………………………

6. Teaching Experience: 1-5 years [ ] 6-10 years [ ] 11-15 years [ ] 16-20 years [ ] 21-25 years [ ] 26-30 years [ ] 31-35 years [ ] 36 and above [ ]

7. Number of years as a Biology teacher in your current school: 1-5 years [ ] 6-10 years [ ] 11-15 years [ ] 16-20 years [ ] 21-25 years[ ] 26-30 years [ ] 31-35 years [ ] 36 and above [ ]

8. Number of Biology periods per week: ………………………

9. Average number of students in your class………………

**SECTION B**

Please, respond to all the items on this page by putting a tick (√) in the appropriate space provided using the following scale: 1=Strongly Disagree, 2= Disagree, 3= Agree and 4= Strongly agree.

| S/No | Items | Strongly Disagree | Disagree | Agree | Strongly Agree |
|---|---|---|---|---|---|
| 1. | I allow students to work on their own while I serve as a facilitator during Biology lessons | | | | |
| 2. | I do not permit students to use their own judgment in solving problems during Biology lessons | | | | |
| 3. | I always demonstrate to students before giving them opportunity to work on their own during Biology lessons | | | | |
| 4. | It is enjoyable having students count on me for ideas and suggestions regarding Biology lessons | | | | |
| 5. | In Biology class, practical work is used to illustrate concepts that have been introduced | | | | |

Please, respond to all the items on this page by putting a tick (√) in the appropriate space provided using the following scale: 1=Good, 2= Satisfactory, 3= Poor.

| S/No. | Items | Good | Satisfactory | Poor |
|---|---|---|---|---|
| 6. | Sufficient laboratory facilities in this school | | | |
| 7. | State of repair of laboratory facilities | | | |
| 8 | Amount of equipment for experiments | | | |
| 9 | State of repair of laboratory equipment | | | |
| 10 | Quality of the student textbook(s) | | | |

Please, respond to all the items on this page by putting a tick (√) in the appropriate space provided using the following scale: 1=Strongly Disagree, 2= Disagree, 3= Agree and 4= Strongly agree.

| S/No | Items | Strongly Disagree | Disagree | Agree | Strongly Agree |
|---|---|---|---|---|---|
| 11. | High performance of students in Biology as a result of practical activities used during teaching and learning | | | | |
| 12. | Most students perform far below average in Biology as a result of lack of practical activities during teaching and learning | | | | |
| 13. | Some students are not attracted to study Biology due to lack of practical activities during teaching and learning | | | | |
| 14. | Lack of understanding by students in Biology due to lack of practical activities during teaching and learning | | | | |
| 15. | Students are able to apply knowledge and skills gained in Biology with the help of practical activities during teaching and learning | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 16. | Students are able to retain knowledge and skills gained in Biology for long with the help of practical activities during teaching and learning | | | | |

**SECTION C**

18. What challenges do you think hinder you in using practical activities in teaching Biology in your school? (Please list them in order of importance, i.e. 1= most important, 4= less important)

1……………………………………………………………………………………
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4……………………………………………………………………………………
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19. In your own view, how do you think these challenges mentioned in Question 18, can be addressed?

(i)……………………………………………………………………………………
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(iv)………………………………………………………………………………………
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**Thank you for your participation in this study**