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TITLE: EFFECTIVENESS OF TEACHING PHOTOSYNTHESIS THROUGH PRACTICAL WORK AT 'O' LEVEL BIOLOGY: A CASE OF GAMBULI SECONDARY SCHOOL

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I certify, to the best of my knowledge, that the required procedures have been followed and the preparation criteria have been met for this project.

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DEDICATIONS

To my mother , brothers, my wife and the entire TAKAENDESA family.

ABSTRACT

Photosynthesis is one of the fundamental biochemical processes on earth. Most living organisms depend on it directly or indirectly. Knowledge about photosynthesis enables us to understand how the world function as an ecosystem and how photosynthesis act as a bridge between living and non-living. It is therefore understandable that photosynthesis is included in the national curriculum around the world. The practice unfortunately shows that learners at all school levels learn about photosynthesis by rote. As a result, they have difficulties in grasping this vital process. There is no doubt that practical work has a positive impact in the teaching and learning of photosynthesis at 'o' level Biology. The use of practical work contributes to successful classroom pedagogy. Questions have, however been raised by some science educators about its effectiveness as a teaching and learning strategy. The purpose of this study was to investigate the effectiveness of teaching photosynthesis through practical work and Gambuli secondary school was used as a case study. Constructive theory by Jerome Bruner guided the study. The study is situated in both qualitative and quantitative research paradgms. Qualitative data was collected through the use of a questionnaire, while quantitative data was collected through pre-test, post-test and delayed retention test. Biology teachers were selected through purposive sampling method. Stratified simple random sampling was used to select 40 form 4 learners taking Biology at Gambuli secondary school. The participants were divided into control group and treatment group. The concept of photosynthesis was taught to the control group through lecture method. The same content was taught to the treatment group through intensive practical work. Pre-test, post-test and delayed retention test were administered to both groups. After the analysis of the results, the mean score revealed a significant difference in the attainment scores of the treatment group over the control group.

According to the research results, it was noted that practical work was more effective in improving learners' performance. Practical work method improve the performance of treatment group which perform better in almost all questions in post-test and delayed retention test than in control group. In the pre-tests, the groups scored more or less the same marks. The ideas postulated by various theorists were incorporated in this study, involving their empirical findings. Findings of this research were presented in tables, graphs and the results indicated that non availability of laboratory equipment, time frame, large classes, syllabus coverage,

poor laboratory conditions and pedagogical content of the teacher are the major constrains towards effective teaching of photosynthesis through practical work. The study made recommendations to Gambuli secondary school, so as to help on better ways and strategies of managing and improving the use of practical work in the teaching of photosynthesis. The study recommend teachers should plan their lessons in a more practical way to enhance learners' attitude as well as achievement. The school administration, teachers, relevant government bodies, NGOs and the community should work closely to make sure that the practical work is conducted effectively. Enough qualified Biology teachers should be employed to cater for increase population of students. The administration of schools should supply their schools with all necessary equipment and chemicals needed to facilitate practical work in the teaching of photosynthesis.

Further studies should be undertaken to explore the use information and communication technology (ICT) in the teaching of photosynthesis through practical work. There is need to conduct a countrywide study that will shed more light on why Biology teachers are reluctant to conduct practical work at secondary school level.

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To the Almighty, God

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CHAPTER 1

INTRODUCTION

1.0 Introduction

This chapter set out the introduction of the study through a description of background, statement of the problem, research questions, significance of the study, limitations, delimitations, assumptions and concludes by giving definitions of important terms in the study. The aim of this chapter was to give readers background understanding of the research problem.

This chapter gives an overview of the study. The effectiveness of using practical work in the teaching of photosynthesis was explained. Emphasis was placed on practical work as an instructional method that gives learners a room to gain confident, scientific attitude and skills through investigation process.

1.1Background to the study

Photosynthesis is one of the fundamental biochemical process on earth. Most living organisms depend on it directly or indirectly. Knowledge about photosynthesis enables us to understand how the world function as an ecosystem and how photosynthesis act as a bridge between living and non-living. It is therefore understandable that photosynthesis is included in the national curriculum around the world. The practice unfortunately shows that learners at all school levels learn about photosynthesis by rote. As a result, they have difficulties in grasping this vital process. There is no doubt that practical work has a positive impact in the teaching and learning of photosynthesis at ‘o’ level Biology. The use of practical work contributes to successful classroom pedagogy. Questions have, however been raised by some science educators about its effectiveness as a teaching and learning strategy. The choice of teaching method to be used depends largely on the information or skill that is being taught (Martins, 2004). Grasha (2001) stress that a teaching method has no value in itself; its value is obtained through the manner in which it is used.

Practical approach was once used by Snezana Stavreva Veselinovska (2011) to investigate the effects of using sequential teaching method on the academic achievement and retention level of students. This study was designed as experimental and carried out with three student groups, each of which included 20 biology students in first year The University "Goce Delcev", Faculty of Natural and Technical Sciences, Institute of Biology. Three student groups of biology students in University "Goce Delcev", Faculty of Natural and Technical Sciences, Institute of Biology, - Stip, R. Macedonia were offered a topic on general characteristics of *Proteins: Their Biological Functions and Primary Structure* with different sequences of 3 teaching methods. The teaching methods were Laboratory method (student experiment), slide demonstration and lecture method.

At first, a pre-test was administered to three groups that each one had 20 students. According to pre-test's results, differences among groups were analyzed statistically by using one-way ANOVA test and there was no significant difference ($P>0.05$) among them. Then, the general concepts and main knowledge of enzymes were taught using three methods in different sequences. The first group started with experiments in the laboratory, then the relevant theory of enzyme was given lecture method, and then the slides were shown by teacher. The sequence of these three teaching methods used in the first group was changed in the second group. In the second group, lesson was started with lecture methods, and then used slide show and the latest experiment were done. The sequence of these teaching methods was also changed and the use of the slide show was initiated, then the experiment was done and the latest lecture method was used in third group. The student experiment's aim was to provide a simple experiment to prove the proteins, reaction which can be easily managed in class. In this experiment, students proved the peptide bones formed among amino acids in the proteins.

Fisher, Fraser and Wubbels (1998) points out that practical work is a central theme of lessons in the natural sciences and are seen as integral part biology and offer students a learning environment that differs in many ways from the "traditional" classroom setting. Killermann (1998) articulates that it is important to consider whether learning is more effective if the students do the experiments themselves or they watch the teacher demonstrating the experiments and simply describing the experiments to the students and telling them the results.

Havice (1999) proclaims that it is hard to imagine learning about science, without doing laboratory experiment. Student practical work underlies all scientific knowledge and understanding and they provide students with opportunities to think about, discuss, and solve real problems. Haynie (1997) stress that no science can be properly taught without student experiments and these experiments should be the central part of science teaching because they are performed to find relations among concepts and to verify hypothesis. Haynie (1997) reiterate that as in other lessons, in Biology lessons the effectiveness is related to the use of teaching methods and some methods may be used together for offering a topic but, the method which increase student academic achievement and retention level is what matters most.

Beydogan (2001) points out that students have more time and opportunities for hands-on experience, active thinking and knowledge reflection. According to this study's results, retention or remembrance level in lesson beginning with experiment and slide demonstration was higher than that of beginning with lecture. Because, people remembrance 10% of what they read, 20% of what they heard, 30% of what they saw and 90% of what they had a hands-on experience.

The work was attempted to establish empirically whether the usage of sequential teaching methods was important for academic achievement and retention. The efficiency was determined quantitatively by a written test.

Sinclair (2004) proclaims that photosynthesis is a central topic in Biology education and remains one of the most challenging, largely because of its limitation to the practical work leading to misconception among students. Ezeife (1996) stressed that practical approach is one of the strategy used in the teaching of photosynthesis at 'O' level Biology. Mackean (1998) points out that photosynthesis is a process which greatly influenced by light intensity,water, carbon dioxide concentration and temperature. Experiments are carried out in Biology laboratory to investigate the effect of these factors on photosynthesis. However, previous research by ZIMSEC (2019) shows that biology teachers across Zimbabwe tend to ignore some of the experiments and move on with the syllabus. Moss (2001) proclaims that Biology teachers have a negative attitude towards practical approach, as it is considered as time consuming and tiresome to prepare experiments. Learners in rural schools of Zimbabwe are the most affected since teachers tend to describe the experiment instead of carrying out investigation because of shortage of resources in some schools such as electricity (Gwarinda, 1995). This had promoted the study to show the application of teaching method used in the teaching process in teaching the content area of biology as well as their empirical confirmation by measuring the achievements of the student.

Martin (2004) stress that learning photosynthesis in Biology is of paramount important because it give learners a picturesque on how the living world behaves and the interrelation of species with photosynthesis as the ultimate source of food for all life on earth.

Ernesto (2005) reiterates that the learning of this topic promotes learners to develop interest in, and practise in caring for the local and global environment. Previous research by ZIMSEC as well as Cambridge (2019) shows that learners perform well when learning the concept of photosynthesis, but find it difficult to interpret and give reasons for certain procedures of experiment in their final examination.

1.2Statement of the problem

This study investigates practical work as a strategy of teaching photosynthesis at 'O" level Biology. Gambuli secondary school 2023 result analysis shows that 80% of the students who wrote the ZIMSEC exam fail. The results were consistence with that of 2022 and 2021.According to ZIMSEC (2021 and 2022), the examiners' reports on Biology shows that the learners have continued performing poorly on the topic photosynthesis. The examiners' reports further pointed out that it is clear from candidates' answers that only a few schools follow a practical approach to the teaching of photosynthesis at 'O' level Biology. Hence this has promoted the study to investigate the effectiveness of using practical approach as instructional method which can improve the academic achievement and retention level of students.

1.3 Research objectives

The study was guided by the following objectives

1. To analyse the benefits of teaching photosynthesis through practical work at Gambuli secondary school
2. To determine the major constraints in the teaching of photosynthesis through practical work at Gambuli secondary school
3. To suggest ways to improve the effectiveness of practical work at Gambuli secondary school.

1.4 Research questions

This study seeks to answer the following questions;

1. What are the benefits of teaching photosynthesis through practical work at Gambuli secondary school?
2. Is there any major constraints in teaching form 4 Biology learners using practical activities?
3. What can be done to improve the effectiveness of practical work in the teaching of photosynthesis at Gambuli secondary school?

1.5 Assumptions of the study

The research assumes that, results from written test provide information that is relevant to practical approach as effective instructional tool in the teaching of photosynthesis at 'O' level Biology. Practical approach has an impact in the teaching of photosynthesis at 'O' level Biology and there is a level of awareness on the effectiveness of using practical approach among Biology teachers. The study does not significantly affect the perceptions of teachers and learners. Pupils answered the test questions to the best of their abilities.

1.6 Significance of the Study

This research brings to surface the different teaching methods for 'O' level Biology in the education sector of Zimbabwe. The study contributes to informed knowledge on the negligence of using practical work in the teaching of photosynthesis at 'O' level Biology due to existence of large classes and shortage of resources such as science equipment in

some schools. The research also contributes to a sound analysis of the importance of using practical activities in Biology teaching and how it can be enhanced in order to contribute towards efficiency and effective teaching. This research add value in the area of policy formulation and implementation in the education sector by recommending on how the practical approach can best be applied and enhanced in the education sector.

The findings from this study might assist the Biology teachers in understanding how to teach practical work. The results of this study might also help Biology teachers to change their attitudes towards practical work in the teaching and learning of photosynthesis at 'O' level Biology. The findings of this study might also contribute to new knowledge that might help Biology teachers to find solutions to the problems of learners who are not performing well in their ZIMSEC practical examination paper in Biology. Biology teachers might also benefit from this study by finding out whether the practical work that they do at their schools is adequate to make their learners ready for the Biology final examination.

1.7 Delimitation of the study

This research is confined to Gambuli secondary school in Makonde district. The school enrolment is about 300 with two science laboratories. Both junior and senior science lab are fully equipped with all the necessary materials and apparatus required for photosynthesis experiments to be successful carried out. The design of this research is that it only focuses on the effectiveness of practical work methods in the teaching of photosynthesis at Gambuli secondary school and does not focus on other schools in Zimbabwe. The research focused on photosynthesis because it is a central topic in Biology which link with other topics such as respiration, transport in plants and ecosystem.

1.8 Limitation of the study

Few studies on practical work have been carried out in Zimbabwe. This has been a limitation in this study because most of literature review come from outside Zimbabwe. During the course of conducting the research, the researcher come across the following shortcomings: The participants were reluctant to participate whereby some learners failed to write the tests in time thereby mounting pressure on the researcher in form of delays to analysis and data presentation. However, the researcher managed to overcome the challenge by making a follow up to make sure that all learners attempt the questions. Financial incapacity is another limitation which forced the researcher to make use of the email to communicate with the supervisor instead of face to face consultation. The school administration was not cooperative in terms of time schedule to meet the learners. However, the researcher make an effort to meet the participants in their spare time. Another limitation is that the teachers might pretend to do practicals when the researcher is present to give the impression that they do carry out practicals.

1.9Definition of key terms

Practical work- is a method of instruction used to teach photosynthesis through the use of empirical evidence obtained through firsthand experience with real materials facts and ideas

Teaching – is defined as an art and science of imparting knowledge for photosynthesis to the students

Biology—is a subject of study at 'O' level dealing with living organisms, describes their characteristics, classification and behavior, how species come to existence and the interaction they have with each other and the environment

Photosynthesis—is a central topic in biology in which green plants make their own food using carbon dioxide and water in the presence of sunlight and release oxygen as by-product.

Constraints- are limitation, restrictions and restraining conditions in the implementation of Practical work method

Laboratory- is a room or building set aside for scientific investigation.

Constructivism- refers to the idea that learners construct knowledge for themselves, each learner individually and socially constructs meaning as he or she learns.

1.10 Summary

This chapter introduces what the researcher is going to study about, clearly showing what promoted the study of the research (statement of the problem). The chapter highlighted the framework of the study which include background of the study, research problem and research questions. The review of related literature will be studied in the next chapter which look more in to the theoretical framework of the study. Chapter 3 will focus on the methodology to be used by the researcher to obtain information. Chapter 4 will provide a discussion and interpretation of the results and evaluation on the success of methodology used. Chapter 5 will summarise the main findings facilitating the drawing up of a conclusion of the entire research.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.0 Introduction

The principal role of this chapter is to critically examine previous theoretical and practical studies concerning practical work as effective instructional method in the teaching of photosynthesis at 'O' level Biology. This chapter identify knowledge gaps between existing literature and the current research topic and establish the means through which knowledge gaps can be filled. This chapter emphasise the role of carrying out photosynthesis experiments in ensuring that learners acquire necessary scientific attitude and skills.

2.1Theoretical Framework

This study is based on the theory of constructivism. Constructivists view learning as an active process whereby learners should learn to discover principles, concepts and facts for themselves. The instructor and the learners are equally involved in learning from each other (Woolfolk, 2004). Crawford (1996) indicated that social constructivists, such as Vygotsky, emphasize the importance of learners being actively involved in the learning process so that they can construct their own understanding. It is believed that learners with different skills and backgrounds need to collaborate on tasks, such as when they are doing practical work together in order to arrive at a shared understanding of the truth in a specific field.

The term “constructionist teaching” is commonly used in the teaching and learning environments (Ritchie and Rigano, 1996).

The teacher according to the constructivist theory is not seen as a person who is responsible for constructing knowledge for the learners but rather is denoted by the many responsibilities given to him/her during instruction in mediating meaning at the inter-mental plane in the classrooms. Thus, the teacher’s role becomes that of a guide provocateur, creator of opportunity and co-developer of understanding with learners. The instructional practices of the Biology teachers should therefore assist learners to acquire the process skills (Ritchie and Rigano, 1996). According to Woolfolk (2004), “Learners should constantly be challenged with tasks that refer to skills and knowledge just beyond their current level of mastery. This will capture their motivation and build on previous success, in order to enhance the confidence of the learners”. Learners need to do practical work so that they can be given activities that would challenge them during the practical lessons.

When learners are doing practical lessons, they will be motivated to learn better by doing, because learners learn better by doing rather than just being taught theoretically. In the constructivist view, learning is a constructive process in which the learner builds an internal illustration of knowledge, a personal interpretation of experience. Learning is an active process in which meaning is accomplished on the basis of experience. Thus, educators must consider learners’ levels of cognitive development when planning topics and methods of instruction (Ritchie and Rigano, 1996).

According to Driscoll (1994), “A social constructivist, Jean Piaget (1953), believed that: learning should be authentic and real. Learners construct their own reality or at least interpret it based upon their perceptions of experiences. Learning should be situated in a realistic setting. A laboratory is a realistic setting, with the instruments for practical work that are found in the laboratory, they make it real life experiences”. Laboratories allow learners to experience reality. Learners do not forget easily what they have seen with their own eyes, and during practicals they can observe with their own eyes and thus experience reality (Driscoll, 1994) further added that “many schools have traditionally held a transmission of instruction’s model in which a teacher or lecturer transmits information to learners”.

In contrast, Vygosky’s (1978) theory promotes learning contexts in which learners play an active role in learning. The roles of the teachers and the learners are therefore shifted, as a teacher collaborates with his/her students in order to help facilitate meaning construction in learners. “Constructivism is a process in which knowledge is both built and tested. Individuals are not free to construct any knowledge, their knowledge must be viable, and it must work. Empirical evidence obtained from laboratory experiments, for example, can be used to test new knowledge” (Ritchie and Rigano, 1996).

2.2 Teaching methods for photosynthesis

Education around the world has developed beyond traditional teaching models. In recent decades, the constructivist theory of teaching and learning has been gaining ground, mostly with regard to the teaching of biology.

Brooks & Brooks (2004) stress that the focal point of the constructivist approach is an interactive teacher-learner relationship, which allows learners to co-create their learning process with an aim to acquire knowledge and apply their own mental activity to develop skills and acquire concepts. In the learning process, learners construct new, meaningful knowledge on the basis of their background, experience, personal qualities, and the environment (Piaget, 1971; Vygotsky, 1978). Klaimn (1995) explains that teachers must identify the cognitive structure of a learner before they can help learners modify their conceptual structures. Numerous studies have shown that constructivist approach is effective, as it improves the learners' understanding and learning outcomes.

It has also been established that the constructivist approach increases learners' interest for biology concepts (Dillon and Dillon, 1995). Learners prefer constructivist approach since it allows them to be more active during class (Klaimn, 1995), exchange opinions with their peers, conduct practical work, take fewer notes, and have more fun.Kolb (1997) points out that instructional method in biology include discussion, concept mapping, problem solving, demonstration and practical work, field trips, project method, lecture method and others. Moore and Miller (2003) points out that demonstration and practical work are methods of teaching photosynthesis. Biology being a science subject requires a lot of demonstration and practical work on part of the teacher this is due to the fact that, photosynthesis involves a lot of practical work which the biology teachers have to carry out. Practical work is conducted through various practical activities.

Practical activities have for a long time been recommended for use in biology teaching. These activities involve the learner wholly when well planned. Biology is fundamentally one of the science subjects implied in this case. Conducting an observation of the surrounding and practical activities both outside and inside the classroom are necessary so as to have an understanding of the nature of science and also to motivate the learners. According Sharpe (2012) practical work refers to any teaching or learning activity which at some point involve the students in observing and manipulating the objects and materials they are studying. Many school science practical tasks, however, do not have this form. It is worth noting that not all practicals require to be conducted in the laboratory. Therefore, the implication is that the absence of a laboratory should not totally deter the use of biology practical approach

Moore and Miller (2003) postulated that, demonstration in photosynthesis teaching simply entails a display or exhibition usually carried out by the teacher while students watch. Certain activities that may require demonstration and practical work include action of iodine solution on green leaf. Lonergan (2000) stressed that, practical work is a method of learning photosynthesis not through what the teacher told the students but through what involves in the process of investigation, carrying out experiments as well as other practical activities. experiments involves activity oriented learning and therefore is a means of acquiring science process skills such as observation, measuring, classification, defining variables, interpretation of data, inferences and predicting.

Nzewi (2001) stress that, concept mapping was developed to improve science teaching and learning through more innovative strategies.

Concept mapping was developed by Novak and his associates at Cornell University 1992. Nzewi (2001) defined concept mapping as schematic device for representing a set of concept using arrows to indicate their relationship in order to represent a new knowledge structure. It also helps both the teacher and the student to pay attention to the major concepts in any given topic. However Dienye and Gbanja (2003) suggested that concept mapping should be used with other strategies so that pupils may not lose interest in the learning process.

Dormer (2000) defined problem solving as the transformation to surmount the barrier between starting situation and the final goal. He further insisted that problem solving is an everyday encounter in the lives of human being which ranges from simple problem situation to problems that are so complex in nature. Problem solving is regarded as an activity oriented learning in which the best result is obtained from an unknown subject through certain set of conditions. Oraifo (2005) noted that the teaching of photosynthesis through the use of problem solving helps to strengthen student's ability towards achievement in Biology because pupils are personally involved in carrying out both mental and manipulate acquisition skills. Gawe, Jacobs and Vikalisa (2004) noted that continuous application of problem solving in classroom situation may discourage some students from participating in the lesson.

Maduabum (2000) stress that discussion approach is another method of instruction in teaching photosynthesis which is an interactive process involving the teacher and the students or among other students themselves. In this case a problem or topic for the lesson is presented for discussion while the teacher helps to direct their views towards the lesson objectives.

He further points out that, for successful implementation of discussion method every student should have background knowledge of what is to be discussed. However Dienye and Gbanja (2003) argues that, discussion method takes a considerable length of time because of each student will be given opportunity to contribute to the discussion and in terms of content coverage it does not lent itself to easy coverage of the syllabus.

Beakes (2007) postulated that, field trips is one of the methods of teaching biology which involves taking students outside the classroom setting to have first hand experiences of what happens in our environment and real life situation. The method enables the student to make useful observations and collect information which cannot be obtained within the classroom. Experiences acquired during field trips are usually long lasting and cannot easily forget by students.

2.3 History of practical work in biology

From the beginning of the eighteenth century to date, educators and researchers have studied the value of practical work and its important role in scientific fields such as Biology (Klainin, 1995), it has been well accepted that practical or empirical work is the major task of scientists. Thus, in order to educate our future leaders in Biology, there is a widespread belief that learners should learn Biology by doing what scientists do (Klainin, 1995). Learning of Biology therefore is seen by most Biology educators as likely to be more effective if the child is involved in practical activities and takes an active part in the learning process. Practical work has been a prominent feature of school Biology teaching from the late nineteenth century when science was established as part of the curriculum of schooling in a number of countries (Klainin, 1995).

The curriculum innovation of the 1950s which started in the United States of America and Europe rapidly spread throughout the world and greatly changed the way science was taught. At the international science conference, funds were made available to develop courses that would allow learners to work like practicing scientists, by allowing pupils to interact with the learning environment and this is one of the reasons why practical work has become a unique feature of biology education. (Tamir, 1991) Zimbabwe has included a practical work component in the teaching and learning of Biology. Learners doing their ordinary level in Zimbabwe are expected to do practical work in Biology. During their ZIMSEC final examination, learners are assessed on practical skills in Paper 3 which is a practical work activity. The inclusion of practical work is clearly stipulated in the new curriculum Zimbabwean biology syllabus (Ministry of Education, 2015). Just as scientists need laboratories to carry out their investigations, schools also need laboratories or special rooms in which learners can carry out experiments. Practical work can only be taught properly if schools are equipped with laboratories where teachers could engage in practicals with their students.

The uniqueness of the laboratory lies principally in providing students with opportunities to engage in the processes of investigation and inquiry (Hofstein, 1998). According to Dillon and Dillon (1995), since the science curriculum reform of the 1960s in the United Kingdom and 1970s in the United States of America, the nature and value of practical work have been examined and evaluated greatly. That is why the current curricula innovations in Science in many countries in the world now focus more on explorations and investigations (Dillon and Dillon, 1995).

Today practical work is seen as having a dual role of facilitating the learning and understanding of Biology concepts and of developing the skills and procedures of scientific inquiry (Millar, 1989).

If practical work is aimed at developing cognitive processes such as handling information and solving problems as well as scientific skills and procedures, students' performance will be high in the practical work assessment. George (1995) emphasized that, since the inclusion of laboratory work into school sciences in many developed and developing countries, practical work has become an integral part of many school science curricula of many countries both in developed and the developing world. The importance of practical work cannot be over-emphasized, but what is of great concern within this past decade is the way practical work has been practised and assessed

2.4 Benefits of practical work in the teaching of photosynthesis at 'o' level biology

Maduabum (2000) points out that, the use of experiments enable students to have direct sensory experience of scientific knowledge for example working with living organism such as green plants it embrace the learner not only to acquire knowledge but also to appreciate life., He further insisted that, using practical method in the teaching of photosynthesis at 'O' level Biology fosters opportunity for the acquisition of meaningful learning of the concept to the point of achieving transfer and application of knowledge.

Hence help students to develop attitudes and skills of a scientist such as enquiry, curiosity, carefulness, objectivity and honesty.

Buttner (2000) stressed that; the great success of practical approach is related with the fact that possible wrong hypothesis on the concept of photosynthesis could be tested after their elaboration being possible and in this case by application of scientific method, the expected conclusions are obtained. At the end of the lesson the teacher would display the contents in a sequential and organised way allowing the students to arrange them in a functional and meaningful way. It was considered that teaching photosynthesis by practical method is in fact a powerful ally in the task of forming, educating and transmitting contents and attitudes, like those that are present in the science domains. According to Jacobs et al (2002) research has shown that retention and recalling of what was learned is linked to experimental experience. He emphasised that learners will remember 90% of what was said and done.

Practical work can motivate learners by stimulating interest and enjoyment, be used to teach laboratory skills, enhance the learning of scientific knowledge, give insights in to the scientific method and develop expertise in using it and, develop scientific attitudes such as open mindedness and objectivity (Hodson, 1990). Well planned practical work can stimulate and engage students' learning at different levels, challenging them mentally and physically in ways that other science have been observed to have higher academic attainment than those taught via the expository approaches.

Similar observations have been posited from a study by Gituthu (2014) who observes that, student-centered teaching approaches have a contribution towards learner achievement in ZIMSEC Biology examination.

Wright (2006) holds the view that the use of experiments creates confidence in one's own abilities is very effective in science teaching because it leaves learners to find out knowledge on their own and in their own ways but under the teacher's guidance. Lederman (1997) emphasised that materials for the lesson should be made available before the science lesson takes off and pupils must be monitored as they carry out their experiments in search of solutions. Moss (2001) reiterates that sometime the method requires learners to go outside the classroom to collect various types of plants for example in Biology Students may discover solutions without comprehending them, so they need the teacher's guidance. Doyle (2008) concurs that the method creates self confidence, promotes self reliance, creativity and intuitive thinking helping learner to deal with real life problems.

According to Martin (2004) practical approach gives the students the opportunity to learn to handle materials and apparatus and does much of the thinking for them if the practical is properly developed. Ernersto (2005) reiterate that the use of experiments encourage students to follow procedures carefully and promote students to perform experiments, record observation and summarise data and draw conclusion. Practical approach usually implies learning by doing. According to (Klainin, 1995) practical work stimulates creativity, curiosity and critical thinking. It also encourage active learning, collaborative working and problem solving (Tamir, 1991).

The goal of practical work are to improve learners' understanding, develop their skills in solving problems and understanding the nature of science by replicating the actions of scientists (Bogner, 2012).

Millar (2004) assets that the role of practical work in the teaching of photosynthesis is to help learners to make links between two domains of knowledge such as the domain of real objects and observable things and domain of ideas. This is in consistence with previous studies by Hofstein and Innetta (1982) who mentioned that laboratory work plays an important role in science education and also helps in understanding the difference between observation and presentation of data. Hodson (1990) considered that practical work can motivate learners and stimulate their interest in teaching and learning. This enhance the learning of scientific knowledge and give them experience in using scientific knowledge and widen their way of thinking.

According to Gututhu (2014) new concepts are taught and introduced which ultimately make the learning process to be inquiry oriented. Biology is a practical subject in which learners need to view real world through it. Practical activities being real, provide an opportunity to link the practical aspects to the theory. This makes learners to have confidence in some of the theoretical content and aspects that they go through during learning while in school. In so doing the learners are able to appreciate that Biology as a science works. Fadzil and Saat (2013) stressed that practical work confers many advantages including developing laboratory skills and scientific knowledge as well as understanding science concepts and theories.

2.5 Disadvantages of practical work method

Weimer (2013) proclaims that the use practical approach in Biology teaching is wasteful in terms of resources to be used in carrying out the investigation and more expensive if separate equipment is provided unlike demonstration. Jeanne (2009) argues that it is also time consuming in carrying out a single experiment because students are unskilled workers. He further emphasised that what the teacher can say in five minutes may take one hour to investigate. It also exposes the teacher's ignorance on those areas he is not competent enough to handle. Doyle (2008) points out that in practical work, lack of background knowledge about the activities may make students to dislike the subject.

Lederman (1997) stress that there is no guarantee that the students will learn to solve problems or think scientifically in the laboratory any more than in another class. Moss (2001) argues that there is some evidence that students of junior high school age learn more readily from demonstrations than by doing and it is difficult to schedule if double periods are provided. Moore and Miller (1996) suggest that there is another problem with practical approach for teaching photosynthesis. Such experiments often have a long history, and many classic early experiments are recovered from antiquity to demonstrate principles to University students.

2.6 Major constrains towards the use of practical work

The reasons behind the failure to use practical work in the teaching of photosynthesis include problem of large classes, learners' and teachers' attitude, poor laboratory conditions, time frame, syllabus coverage and pedagogical content of the teacher.

2.6.1 Problem of large classes

Lack of qualified Biology teachers is one of the drawback towards the use of practical work in teaching of photosynthesis at 'o' level Biology. As a result of this shortage most teachers have to teach more than the required number of learners. Dormer (2000) points out that, there are significant problems associated with teaching the practical aspects of photosynthesis. In large classes, learning outcomes are affected by the quality of demonstration and success of particular experiment. This can result in variability within and between practical classes, in any cohort which has any implication for equity and well as for learning outcomes generally. Jeanne (2003) articulates that smaller classes benefit all pupils because of individual attention from the teacher.

Newkirk (2005) stress that student achievement increases significantly in classes of fewer than 20 smaller classes, completed by diverse teaching methods create better student performance, more positive attitudes and fewer discipline problems. Pupils in large classes drift off the task because of too much instruction from the teacher to the whole class instead of individual attention. According to Weimer (2013) student –teacher ratio is the number of students who attend school divided by the number of teachers. For example, a student- teacher ratio of 10:1 indicates 10 students for 1 teacher.

Martin (2004) states that class size reduction show more positive teacher-student interactions leading to less time spent on discipline. According to Beakes (2007) smaller classes allow for potential disciplinary problems to be identified and resolved more quickly.

According to Bracey (2005) effective learning demands opportunities for students to become actively involved in their education. Teachers are demanded to play roles such as facilitator, enabler not only as lecturer and transmitter of knowledge. These opportunities and roles cannot be achieved when teachers are faced with large classes and heavy workloads.

Rose (2006) states that the larger the number of students in a class, the greater the amount of time devoted to classroom management rather than instruction. A teacher who faces 25 students in a class period of 50 minutes has no more than 2 minutes, at best per pupil for one to one interaction during any period.

2.6.2 Non availability of laboratory equipment

Bulman (2003) points out that, the availability; reliability and condition of the equipment are considered before conducting practical approach. The physical facilities available must also be borne in mind such as availability of electricity. Lederman (1997) insisted that, laboratory exercises are available but revolve equipment and procedures that are unreliable and prohibitively expensive are questionable. Hence financial constraints may impede conducting experiments on photosynthesis. Moss (2001) points out that science teachers often try to teach students about scientific principles through the use of lab experiments, though they do not always have access to the resources needed to optimally perform experiments. Kolb (1997) emphasized that in a science classroom, teachers may not be able to access everything that they need in order to deliver effective instruction. Schools often run short of important items like science equipment because they have been lost, were never ordered, are broken or are just too expensive to purchase (Mutasa and Wills, 1995).

2.6.3 Learners and teachers attitudes

According to Rajan (2002) teachers and learners attitude have a great implications on learners performance in the teaching of photosynthesis through practical work. Teachers' approach in the teaching of photosynthesis through practical work has effects on learners' attitude towards the topic photosynthesis. A situation where the teacher monopolises the teaching and learning process of photosynthesis with less participation of learners could result in apparent lack of interest in the topic hence poor performance.

2.6.4Time frame

Bell and Beverly (2000) reviewed that, they are some very elegant experiments and procedures that are often slow and require precision to gain meaningful results for example gas exchange for classic elodea experiment. Significantly if students are unclear about the principles before the practical and take insufficient care in collecting the data, they may gather data that is inconsistent with the theoretical expectation, rather than clarifying concepts this will merely reinforce misconception.

Lederman (1997) postulated that for a biology teacher to carry out effective Biology practicals in the Laboratory, careful planning and proper organization are necessary. To this effect, he/she needs to assemble in advance all the equipment and materials for the exercise. Furthermore, he/she has to ensure that they are also in good working condition. Subsequently, the experiment is trial tested by carrying it out first to ensure that the chemicals to be used are still very active and the procedure carefully followed by the teacher.

Haya (2001) propounds that pre-laboratory session is very important because it reduces errors which the teacher may have committed in the actual laboratory session. Also the sitting arrangements of students are put into consideration as well as the time to spend in carrying out the investigation.

2.6.5Pedagogical content knowledge of the teacher

Gwarinda (1995) points out that the two main methods are teacher centred and child centred approach. In the teacher centred approach, the teacher concentrates on fully giving information to the learner. It is assumed that the teacher knows the best and hence directs all learning. The teaching dominates over learning and pupils are assumed as empty vessels into which information is to be poured. Bell (2000) expressed that new methods and techniques are being employed in the teaching of science. It is therefore desirable that biology teachers are trained and well versed in knowledge of preserving specimens and animals, techniques of evaluation and lesson unit planning. Hence if the pedagogical content knowledge background of the teacher is poor, other instructional methods may be used in place of experimental approach such as lecture method which does not expose students to greater learning opportunity by doing it.

Weinstein (2003) points out that the teacher should have knowledge of the science and behavior of his students in order to handle them effectively in the teaching- learning process. He/she should try to impart knowledge and skills to then according of their mental abilities, capacities, interests and attitudes, as well as emotional and social make up.

Martin (2004) proclaims that if the teacher is well equipped he/she may help the students to undergo a battery of intelligence tests a science stream of the curriculum. In this way, if scientific knowledge is imparted to the deserving students it will make the tasks of the teacher and the taught easier.

Jeanne (2009) emphasized that the knowledge of other tests and psychological measurement will help the teacher to understand the ability, and behavior potential of the child at the different stages of learning or development and consequently bring changes in mode of behavior and methods of teaching. Hayo (2007) reiterates that it is also essential for a science teacher for being trained in the latest techniques, strategies and methodology of teaching science including the use of the all type of aid material and developed technology.

2.6.6 Poor laboratory conditions

According to Dormer (2002)Biology laboratories should possess the following features for effective learning of photosynthesis through practical work. A fairly large room with demonstration and preparatory room and the stores. Long tables with sinks, four way type of gas points, two reagents shelves, water supply taps and drawers, gas chamber, fume cupboard, refrigerator and air conditioners, raised plat-forms and safety devices. However most of our secondary school laboratories fall short of this standard and hence provide a negative impact on learners (Martin, 2004).

2.6.7Syllabus coverage

Rajan (2002) points out that in terms of syllabus coverage, practical approach does not lend itself to easy coverage of the syllabus. This is because concepts and theories that can be described and explained in five minutes may take one hour to investigate and clarify the hypothesis. It is often very difficult to design a really good experiment. Lederman (1997) proclaims that it can take a scientist several months or years to design a good experiment that that prove hypothesis.

2.7Teacher's attitude towards application of practical work

Zuckerman (2001) postulated that, teaching photosynthesis by practical approach is an uphill task since the method requires exhaustive preparation of classes regarding the selection of materials and setting up of experiments. He further insisted that experiments require careful planning and design. It is often difficult to design a really good experiment. In terms of content coverage, practical approach does not lend itself to easy coverage of the syllabus. Hence with that notion in mind Biology teachers tend to describe experiments instead of carrying out experiments.

Martin (2004) stress that Biology teachers assume that, students are unskilled workers and therefore giving them opportunity to play around laboratory equipments is a mere wastage of time because no meaningful results are obtained at the end but rather generating confusion teachers' attitudes have been reported to have implications on students' performance in practicals (Adeleye, 2002). Teachers approach in the teaching of Biology practicals has effects on student attitude toward the subject.

A situation where teacher monopolizes the teaching and learning process with less participation of learners could result in apparent lack of interest in the subject and hence poor performance.

2.8 Ways of improving the teaching of photosynthesis through practical work

Various ways can be done to improve the effectiveness of practical work in the teaching of photosynthesis at Gambuli secondary school. These include the provision of standard laboratory and adequate laboratory equipments. There is need for teachers to make sure that materials are available and improvise where possible. This is in harmony with Balman 2003 that, the availability, reliability and condition of the equipment are considered before conducting practical activitity. There is need for learners to be allowed access to laboratory equipments so as to familiarise with them. There is need for teachers to assemble in advance all the necessary materials and equipment to be used for practicals and budget their time well. Preparation of materials in advance saves time and allow experiments to be successful.

Enough Biology teachers should be employed to cater for increased population of learners and deal with the problem of large classes. There is need for teachers to improve their teaching methodology to sustain the interest of learners. This is consistence with Haynie (1997) that no science can be properly taught without experiments and these experiments should be part of science teaching because they are performed to find relations among concepts and to verify hypothesis. There is need for training and workshops for teachers which emphasize on the use of practical work methods and how they can be improved to enhance learners' performance.

This is in harmony with Killerman (1998) that is important to consider whether learning is more effective if learners are to do experiments themselves or they watch the teacher demonstrating the experiments and simply describing the experiments to the learners and tell them the results.

2.9Summary

This chapter dealt with the information researched on the topic teaching photosynthesis using practical work method and it covers the literature review of importance of practical method and the limiting factors on the implementation of practical work in Biology as well as ways of improving the teaching of photosynthesis through practical work. Also included is the theoretical framework and previous findings. The next chapter will look on the methodology to be used by the researcher to obtain the information.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0Introduction

This chapter gives attention to the research methodology used for the study. Focus is on the research paradigm, research design, population and sampling technique, data collection methods, data presentation and analysis procedure, ethical considerations, validity and reliability of the findings.

3.1 Research paradigm

In the context of educational research, Polit and Beck (2004) as cited in Kivunja and kuyini (2017) define the term paradigm as used to describe a researcher's 'worldview'. This pertains to the methodology used by the researcher to interpret data. The study was guided by both qualitative and quantitative paradigm. In this particular study, the justification for taking both qualitative and quantitative approach is that it allows the researcher to tackle a broader and more complete range of research questions owing to the fact that the research is confined within the tenets of a particular method of research. Qualitative data was used to support quantitative data as well as quantitative data being used to support qualitative data which provide a balance to the study. The combination of qualitative and quantitative studies is vital in addressing the contradiction that exist in research. One of the strength of mixed research paradgms is that it allows the researcher to produce more complete knowledge necessary to inform theory and practice.

3.2 Research design

Research design is the conceptual blueprint within which research is conducted (Driscoll, 1994). Therefore, a research design is an exposition of the way the study conducted; that is, the plan that guides the undertaking of a research to meet the research objectives.Research design is concerned with turning the research questions into a well informed project and its function is to ensure that the evidence obtained enables us to answer the initial questions unambiguously as possible. Ritchie and Rigano (1996) argues that research design is a master plan that specifies the methods and procedures for collecting and analyzing data. The goal of the research design is to provide results, which are credible and should resemble reality and are true and reasonable. The design considered appropriate for this study was mixed research design since the aim of this study is to assess the effectiveness of practical work method in the teaching of photosynthesis at 'o' level Biology.

Data regarding learner's achievement were collected before and after the experiment. Assessing learners' achievement towards the topic photosynthesis require the use of quantitative data. Thus quantitative data were obtained from experiment of sample from form 4 Biology learners. A case of Gambuli secondary school was used to gather information for teaching photosynthesis through practical work. This design ensures that learners ability in group 1 and 2 were the same. The experimental group and the control group consisted of 20 learners each. All participating learners were pre-tested to determine their level of science content understanding. This was done to ensure homogenity of the two groups before starting the intervention, thus learners in both control and experimental groups had the same academic level and pre-test scores.

For a period of four weeks, the control group learners were taught using the traditional lecture method while the experimental group learners were taught using the intensive practical work method. Thus, for the experimental group, all the teaching hours were taught in the laboratory. After the intervention was completed, the post-test was conducted to measure the learners' attainment. The data was collected and statistically analysed to explore any significant differences in the attainment mean scores of the control and experimental groups. Qualitative data were collected from questionnaire of four Biology teachers at Gambuli Secondary school.

The use of random assignments reduces errors that might occur with using intact groups. The study used the principle of instructional design to plan the lesson that is by giving the whole task problem for learners before starting the lesson and using materials found in the environment to perform experiments on photosynthesis. The intervention was then made. Then an assessment of the effectiveness of practical work to enhance learners' achievement level was conducted. The collected data for the effectiveness of practical work method in the teaching of photosynthesis was categorised for analysis by quantitative and qualitative methods. The results obtained from quantitative data were then presented separately in the interpretation phase. The design was used because it was appropriate for the research problem and condition of the research.

3.3 Population

According to Birn (2000) population consists of the aggregate of items from which the sample is drawn. A population includes all individuals from whom the researcher desires to obtain information upon which to make conclusions on the basis of the sample drawn from the population. Accordingly the population of this study was taken from all form 4 learners taking Biology at Gambuli secondary school.

Henning, Van Rensburg and Smith (2004), defined population as a group of individuals who have one or more characteristics in common that are of interest to the study. The major characteristics of this population are that they are all form four learners at Gambuli secondary School and they are all doing Biology and they all covered the topic under study 'photosynthesis'.

3.4.1Sample

A sample is part of a larger population. It is usually selected to be representative of the population. Those included in the sample were chosen as a cross section of the larger group. The sample includes 40 Biology learners to provide information to the effectiveness of practical work method in the teaching of photosynthesis at Gambuli secondary school. The research focused more on 'O' level Biology learners because are the pupils that were directly involved in giving first-hand information to the research area and deemed adequate to provide credible accuracy and success. If the sample is chosen carefully, it is possible to generalize and to make statements about the whole relevant population on the basis of the sample. Zikmund (1988) suggests that the purpose of sampling is to enable researchers to estimate some unknown characteristic of the population.

3.4.2 Sampling techniques

All form 4 learners taking Biology at Gambuli secondary school were the target population. Stratified simple random sampling method was used in selecting f-= 20, m= 20, t= 40, 'o' level Biology learners for the completion of pre-test, post-test and delayed retention test. A lottery method was applied in selecting the respondents. Purposive sampling method was used to select four biology teachers at Gambuli secondary school.

3.5Research Instruments

These are tools used for data collection. George (1995), states that a research instrument is any relevant tool used in research to gather information. Appropriate tools are required if desired and valid feedback is to be derived which gives consistence and accurate information. The efficiency of practical work method was determined quantitatively by in class tests. Using pre-post design, inferences were made after analysing results from written tests. Research instruments used in this study were questionnaire for teachers and pre-test, post-test and delayed retention test for learners.

3.5.1 Questionnaire

Saunders (2007) defines questionnaire as a list of all the questions which addresses the objectives or hypothesis of a research study. Best and Khan (2006) states that questionnaire is a peformulated written set of questions to which respondents record their answers within rather closely alternatives.

According to Mellenbergh (2008) a questionnaire is a research instrument consisting of a series of questions and other prompts for the purpose of gathering information from respondents.Johnson and Christensen (2008) defined a questionnaire as a "self-report data collection instrument that each research participant fills out as part of a research study". They further indicated that researchers use questionnaires so that they can obtain information about the thoughts, feelings, attitudes, beliefs, values, perceptions, personality and behavioural intentions of the research participants. In this study, the researcher set up a questionnaire for the form 4 Biology teachers. The questionnaires had both closed and open ended questions for the maximum utilisation of the opportunity in the data gathering. The questionnaire had 3 sections. Section 1 had questions on the attitudes of the teachers towards the use of practical work in the teaching of Biology; Section 2 had questions on how teachers use practical work in the teaching of Biology, and Section 3 had questions on the views of teachers on the importance of practical work in the teaching of Biology. (See Appendix E)

A single set of questionnaire was developed by the researcher for four Biology teachers. The researcher physically distributed the questionnaires to the respondents on the agreed dates and

was given dates to come and collect the completed questionnaires.
The major strength of using questionnaires in this study were that:

- Meaningful and thoughtful data was acquired given that respondents were given time to respond at the time convenient to them.

- The questionnaires enabled the researcher to cover a large portion of the sample within a short period of time. This is because no time was spent in asking questions; it was just a matter of dropping and picking the questionnaires.
- They enabled participants to respond to questions at their own pace and had time to think about the questions before responding.
- Participants provided information at length without being interrupted.
- It is an effective way of collecting factual and sensitive information because it wiped out the verbal communication barrier.
- It helped the researcher to capture large volumes of data within a short period of time.
- The cost of sending the questionnaire was low.
- They were free from bias which would otherwise arise in an interview.

Weaknesses encountered in the use of questionnaires were that:

- Some questionnaires were not answered on time.
- Some respondents did not respond to the entire questionnaire.
- Control over who actually completed the questionnaire could not be achieved.
- The method was not suitable when the researcher was absent as the participants failed to interpret some of the questions correctly hence the researcher did not have control or say over the information collected.
- The researcher had to make several reminders to the participants before the collection date.

In this study the questionnaire was developed in relation to sub problems developed in chapter one.

3.5.2 Pre-test and post-test

This component requires that the research collected data on study participants' level of performance before the intervention took place (pre) and that the same data is collected on where study participants after the intervention took place (post) (Lederman ,1997). This approach to scientific enquiry is a better way to evaluate whether or not an intervention has an effect on the study sample. In the contest of this study the performance of the Form four biology pupils were assessed on the topic photosynthesis before methods application (pre-test) and then assess them after these methods application (post).

3.5.3Treatment - Control Groups

The treatment group is the collection of research subjects who get the application of the variable under study. The control group on the other hand does not receive the treatment of the factor under investigation. In fact these groups are tasked to undertake the program or activities without the inducement of the factors being investigated. The ability level of both control and treatment groups were the same. In the context of this study these groups were made up of form four classes doing Biology. The treatment group 2 was comprised of the class (4C) which was taught the topic photosynthesis through practical work, while the control group 1 was made up of (4A) in which the relevant theory of photosynthesis was taught through lecture method.

3.5.4Random Assignment of Participants

The laboratory research approach require the research to randomly assign participants into groups to ensure that any differences between the treatment group and control group are not due to selection bias but by chance (Lonergan, 2004). The study uses scientific enquiry

approach because it allows the manipulation and control of variables without putting in much personal bias.

The study was designed as experimental research design and carried out with a sample of two learners groups. Each of the group includes 20 Biology learners with 10 girls and 10 boys. In selecting the subjects of this research, random sampling was used to choose the classes that are to be used as the control and treatment groups for the study. In doing so, the teacher wrote numbers 1 to 5 on cards to represent the five classes at the school. The cards were then put into a box and with the help of a fellow teacher two cards were picked randomly and those that were picked were 4A and 4C. The selected cards were then put back into the box and randomly picked for the second time to select the control class. The card that was picked first (A) was made the control group and the card (C) that remained in the box was considered as the treatment group.

3.6.1 Data Collection procedures

Data were collected from ‘o’ level Biology teachers and learners in the science department. The research was conducted using primary sources of data including questionnaire.

3.6.2 Questionnaire for teachers

The questionnaires were distributed to ‘o’ level Biology teachers at Gambuli secondary school. The respondents were asked to indicate their view on the questionnaire by ticking the appropriate answer or to write in the space provided. The respondents were given enough time

to answer the questions and were allowed to ask on areas which needs clarification. After completion on the questionnaire, the researcher collected the questionnaires and analysed the answers.

3.6.3 Pre-test, post-test and delayed retention test for learners

Data was collected from a sample of two learners' group. Each of the group includes 20 Biology learners with 10 girls and 10 boys. In selecting the subjects of this research, stratified random sampling method was used to choose the classes that were to be used as the control and treatment groups for the study. In doing so, the teacher wrote numbers 1 to 5 on cards to represent the five classes at the school. The cards were then put into a box and with the help of a fellow teacher two cards were picked randomly and those that were picked were 4A and 4C. The selected cards were then put back into the box and randomly picked for the second time to select the control class. The card that was picked first (A) was made the control group and the card (C) that remained in the box was considered as the treatment group.

The two selected groups of Biology learners were personally visited. Participants from the selected sample were informed about the purpose and objectives of the study. The respondents were informed that they were free to participate and withdraw at any time from the study.

The respondents were informed that they are going to write pre-test, post-test and delayed retention test. The three tests contained six questions on photosynthesis with a total weight of 30 marks. To ensure validity and reliability of the questions, the researcher used the same questions in all the tests but only differentiated the wording and numbering of the questions. A pre-test was administered to two groups of form 4 Biology learners. According to pre-test

results, there was no significant difference among them.

The concept photosynthesis was taught using different teaching method in each group. The teaching methods used were practical work and lecture method. The relevant theory of photosynthesis was taught to the first group through lecture method. In the second group, the concept photosynthesis was taught through practical work. The main objective of the lesson was to investigate factors affecting the rate of photosynthesis. A Post-test was then administered to both groups. Then the academic achievement and retention level of learners from the two groups were quantitatively analysed and recorded to determine the efficiency of practical work method. After a period of 30 days the learners were then asked again to write delayed retention test. Accordingly, academic achievement and retention level of learners from control and treatment group were quantitatively recorded and analysed to evaluate the effectiveness of teaching photosynthesis through practical work. The tests ask learners to define photosynthesis, describe how a leaf is treated before setting up photosynthesis experiments; factors affecting photosynthesis and leaf adaptation to photosynthesis see APPENDIX B-D.

3.7 Reliability and Validity

Reliability is synonymous with repeatability. A measurement that yields consistent results over time is said to be reliable. When a measurement is prone to random error, it lacks reliability. The reliability of an instrument places an upper limit on its validity (Spector, 1981) in David S. Walonick, 2010. According to Miller (1997) reliability is the extent to which a questionnaire, test, observation or any measurement procedure produces the same results on repeated trials.

Validity refers to the accuracy or truthfulness of a measurement. Are we measuring what we think we are? "Validity itself is a simple concept, but the determination of the validity of a

measure is elusive" (Spector, 1981,).Miller (1997) also defines validity as the extent to which the instruments measures what it purports to measure.

Taking from the above definitions, this research could be ascertained to be fairly reliable and valid. To ensure reliability of research results, the questionnaire was carefully crafted, analysed and pre-tested. Through this process, the researcher was able to identify further items of mutual concern to the researcher and the respondents and those questions that may have had ambiguous meanings to the key informants. Necessary adjustments were made to them accordingly, making the final questionnaire used in the study more valid and reliable.

In order to guarantee validity, the researcher made sure that the researched results were directly related to future effectiveness of teaching photosynthesis through practical work since the respondents were carefully selected from ‘o’ level Biology teachers. This was done to ensure that only qualified respondents answer the questions. Respondents also got the time to analyse the questionnaires before responding, hence giving quality and accurate data.

3.8 Data presentation and analysis procedures

Data presentation and analysis was based on results obtained from in-class tests. Having obtained feedback from respondents, the records of results obtained from written tests were organised, and analysed using a combination of tables, graphs and pie charts so as to extract pertinent information for teaching photosynthesis through practical work at Gambuli secondary school. The percentage obtained by learners from in-class tests were presented through graphs. Data obtained from questionnaires and in-class tests was analysed through quantitative techniques to determine the efficiency of practical work method in the teaching of photosynthesis at Gambuli secondary school. The performance of the pupils was analyzed per individual questions on the pre-test, post-test and delayed retention test. Quantitative methods were also used to explain the results of the test given to learners.

3.9 Pilot study

A pilot or feasibility study is a small version of a full scale study. It also refers to specific pre-testing of a particular research instrument such as a questionnaire (Patton, 1990). An advantage of a pilot study is that it can give advance warnings of possible failure of the main project, indicate where research protocols might not be followed or whether proposed methods and instruments are inappropriate or too complicated (Patton, 1990).Birn (2000) states that a pilot study is a small scale dress rehearsal that precedes as if it were the actual study, except for the fact that the subjects who will participate in the actual study were not used. Before the actual implementation of the research and data collection, the researcher conducted a pilot test of the questionnaire. A pilot study was conducted for this study. A trial run of the questionnaire was done with a separate group of three Biology teachers. Respondents were given questionnaires to fill and asked to return within a week. Gambuli secondary school was used for this purpose with 3 Biology teachers and 20 form 4 Biology learners. The main aim was to test whether the instruments were giving the information that was expected. The three Biology teachers and 20 form 4 Biology learners were chosen purposefully from Gambuli secondary school as one of the secondary schools in Makonde district.

These three Biology teachers were given questionnaires to fill in and the learners were given an in-class test on the topic photosynthesis after learning photosynthesis through practical work and lecture method respectively. These three Biology teachers were also given enough time to prepare their lessons on photosynthesis and deliver them through practical work and lecture method. The piloting process was completed within a week and the findings were analysed thereafter. Questions on in-class test and questionnaire were refined, biased and ambiguous questions were revised. The observation schedule was also rectified by adding the necessary questions and by removing the unnecessary questions. Following suggestions made by respondents and a thorough analysis of the three copies of the questionnaire, improvements were made on the questionnaire by having questions redesigned to come up with the final questionnaire.

3.10 Ethical and Legal Considerations

In this research study, fundamental ethical principals were applied. Polit and Beck (2004) defines research ethics are moral obligations and principles that researchers should adhere to

in carrying out and reporting their studies. Brooks and Brooks (2004), stresses that research ethics are important in that they enable the researcher to develop meaningfully acceptable research protocols that are worth the participants' time and have a reasonable chance of yielding meaningful findings, protects the rights of participants' and report results fairly and accurately. In respect of this, the researcher obtained a written authorization will be obtained from all relevant authorities such as the Gambuli secondary school and also sought for written consent from participants before gathering data. The researcher also observed both national as school rules and regulations governing school operations and research such as informing all participants on the purpose, benefits and possible risks of their involvement in the research study in order to ensure voluntary participation. The respondents' privacy was highly respected while all responses were treated confidentially. The researcher further avoided the falsification of data in order to maintain the integrity and objectivity of the research study.

3.11 Summary

This chapter gave a detailed description of research design employed to provide the overall strategy for answering the research questions for this project. It highlighted tools and techniques used in primary data collection. The next chapter builds up on this basis, analysing and presenting in a systematic form. A detailed discussion and interpretation of the results of the analysis will be provided in the next chapter where the evaluation on the success of the methodology discussed is also done therein.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.0 Introduction

In the preceding chapter, the methodology, research design and methods that were used in collecting data were described. The instruments that were used in generating data in this study were pre-test (Appendix B), post-test (Appendix C), delayed retention test (Appendix D) and questionnaire (Appendix E). In this chapter, the results from the study are presented.The scores from the pre-tests, post-tests and delayed retention test were analysed to find out if there was any statistically significant difference in the performance of the learners. The responses on the questionnaires were used to explain the quantitative results. The analysis of the tests produced data that was used to ascertain the effectiveness of practical work in teaching of photosynthesis. The chapter present a detailed analysis of the research findings through the use of statistical descriptions involving the construction of tables, graphs and pie charts. The findings obtained will be linked to the research questions, objectives of the study and used to draw conclusion in the next chapter.

4.1 Response rate to the questionnaire

The researcher designed a questionnaire which was sent out to Gambuli Biology teachers and the response rate to the questionnaire was illustrated on the table below.

Table 4.1 response to the questionnaire

Description	Number	Percentage
Questionnaires sent out	4	100%
Responses	3	75%
Non responses	1	25%

Source: Primary data.

The researcher distributed 4 questionnaires and 3 were answered which was 75% of the sample.

The response rate of 75% was considered sufficient to warrant analysis of the results. The 25% non-responses were attributed to only one Biology teacher who had other businesses to attend

to. Generally, the researcher was satisfied with the number of respondents for a conclusion on the findings to be drawn.

4.2 Biology teachers' perception of the importance of practical work at Gambuli secondary school

This theme addressed the perceptions of the Biology teachers on the importance of doing practical work in the teaching of photosynthesis. Teachers were asked whether practicals were necessary in the teaching of the topic photosynthesis. All 3 teachers agreed. Table 4.2 presents the reasons that the teachers gave as to why practicals were important in the teaching of photosynthesis.

Table 4.2: Why practicals are important in the teaching of photosynthesis at Gambuli secondary school (N=3).

statement	frequency	percentage
Practicals prove theory in Biology, and make Biology an interesting subject	2	67
Practicals promote learners understanding of the topics better, and stimulate interest in the subject	3	100
Learners develop skills on handling and organizing apparatus and materials and following instructions	2	67
Learners learn better when they see and touch objects, they don't forget what they saw, and this reinforces the content	2	67
Slow learners understand the content better; master the content through investigations and observations	3	100
Practicals yield better results in Biology and prepare learners to answer questions in Paper 3 during ZIMSEC exam	3	100

From Table 4.2, 2 (67%) of the teachers indicated that practicals were necessary in the teaching of Biology because practicals proved theory in Biology and made Biology an

interesting subject. This is consistence with Maduabum (2000) who points out that, the use of experiments enable students to have direct sensory experience of scientific knowledge for example working with living organism such as green plants it embrace the learner not only to acquire knowledge but also to appreciate life., He further insisted that, using practical method in the teaching of photosynthesis at 'O' level Biology fosters opportunity for the acquisition of meaningful learning of the concept to the point of achieving transfer and application of knowledge. Hence help students to develop attitudes and skills of a scientist such as enquiry, curiosity, carefulness, objectivity and honesty.

The majority of the teachers indicated that practicals promoted learners' understanding of the topics better, and also stimulated students' interest in Biology. This is consistence with Ernersto (2005) who reiterate that the use of experiments encourage students to follow procedures carefully and promote students to perform experiments, record observation and summarise data and draw conclusion. Practical approach usually implies learning by doing. Two (67%) of the teachers indicated that practicals developed learners' skills on handling and organizing apparatus and materials and in following given instructions. Therefore, practical work can motivate learners by stimulating interest and enjoyment, used to teach laboratory skills, enhance the learning of scientific knowledge, give insights in to the scientific method and develop expertise in using it and, develop scientific attitudes such as open mindedness and objectivity (Hodson, 1990).

Two (67%) of the teachers indicated that practicals allowed learners to learn better when they saw and touched objects, they do not forget what they have seen and this reinforces their content grasp. This is consistence with Jacobs et al (2002) research which has shown that retention and recalling of what was learned is linked to experimental experience. He

emphasised that learners will remember 90% of what was said and done. Three (100%) of the teachers indicated that practicals allowed slow learners to understand the content better, master the content through investigations and observations while three (100%) of the teachers said that practicals yielded better results in Biology and prepared learners to answer questions in Paper 3 during ZIMSEC exam. This is consistence with Wright (2006) who holds the view that the use of experiments creates confidence in one's own abilities and is very effective in science teaching because it leaves learners to find out knowledge on their own and in their own ways but under the teacher's guidance. From the teachers' responses, it was clear that all 3 (100%) of the teachers were aware what practical work was all about and why it was necessary in the teaching of Biology.

As indicated by Clackson & Wright (1992), Gott & Duggan (1995), and Leach (1999), a teacher's belief or conception of practical work can impact directly on the way she/he arranges practical work. Teachers should therefore have a clear understanding of what practical work entails and the purposes it serves. Having a clear understanding about the nature of practical work might help the teachers to plan teachable practical activities. Teachers were also asked whether lack of a Biology laboratory would prevent them from doing practical work in Biology.

2 (67%) of the teachers indicated that not having a laboratory could not prevent them from carrying out practicals in Biology, while the remaining 0ne (33%) of the teachers said that if there was no laboratory at school then they would not be able to carry out practical work in Biology and thus were not carrying out the practicals. The teacher, who indicated that if the school did not have a Biology laboratory, then they would not carry out practical work with

their learners, explained that “classrooms were not conducive for conducting practicals, as some practicals were dangerous to be carried out in the classrooms”.

The 2 teachers who indicated that lack of a laboratory would not prevent them from carrying out practicals in Biology explained that “if there was no laboratory at school, then one should use the classroom or the outside to conduct the practicals” Whether the school has a laboratory or not, learners will still write Paper 3 examinations at the end of the year. Accordingly, teachers need to expose learners to practical work if they are to do better in Paper 3. This implies that learners must be exposed to practical work and demonstrations. If learners are not exposed to practical work, due to the lack of a laboratory for example, they might not be able to answer questions on Paper 3 and this in return might affect their final performance in Biology.

4.3 Is there any statistically difference in the academic performance of learners taught using practical activities and lecture method in the pre-test, post-test and delayed retention test

The quantitative results show that there was a statistically difference in the academic performance of learners taught using practical activities in the pre-test, the post-test and delayed retention test see table 4.3, fig 4.1 –fig 4.7 for quantitative analysis.

4.4 Response Rate to the in-class tests

The response rate for the pupils took part in pre-test, post-test and delayed retention tests are given in the table 4.3.

Table 4.3 Response Rate to the in-class tests

	Pre-test	Post-test	Delayed retention test
Control class 4A	100%	98%	96%
Treatment class 4C	100%	96%	98%
Response rate	100%	97%	97%
Overall response rate			97%

The response rate for the pupils in the pre-test, post-test and delayed retention test are given in the table 4.3. As indicated, the number of pupils who wrote the pre –test in the control class constituted 100% of the class and those who sat for post-test in the same class amounted to 96% of the class. 4% of the class were absent on the post-test and 2% were absent in delayed retention test. On the treatment class 3% of the class were absent for the post-test and delayed retention test. All the pupils who were present in both the treatment and control class wrote the test. The response rate for the two classes for the pre-test was 97% and for the post test was 96%. The overall response rate for both the pre and post-tests was 97%. Basing on the figures given above, one can safely say that the number of respondents who participated in both the pre and post-test is quite representative of the study sample.

4.5.1Definition of the term photosynthesis

The question required the pupils to define photosynthesis. The average group performances for question 1 in pre-test, post-test and delayed retention test after 30 days were as shown on fig 4.1

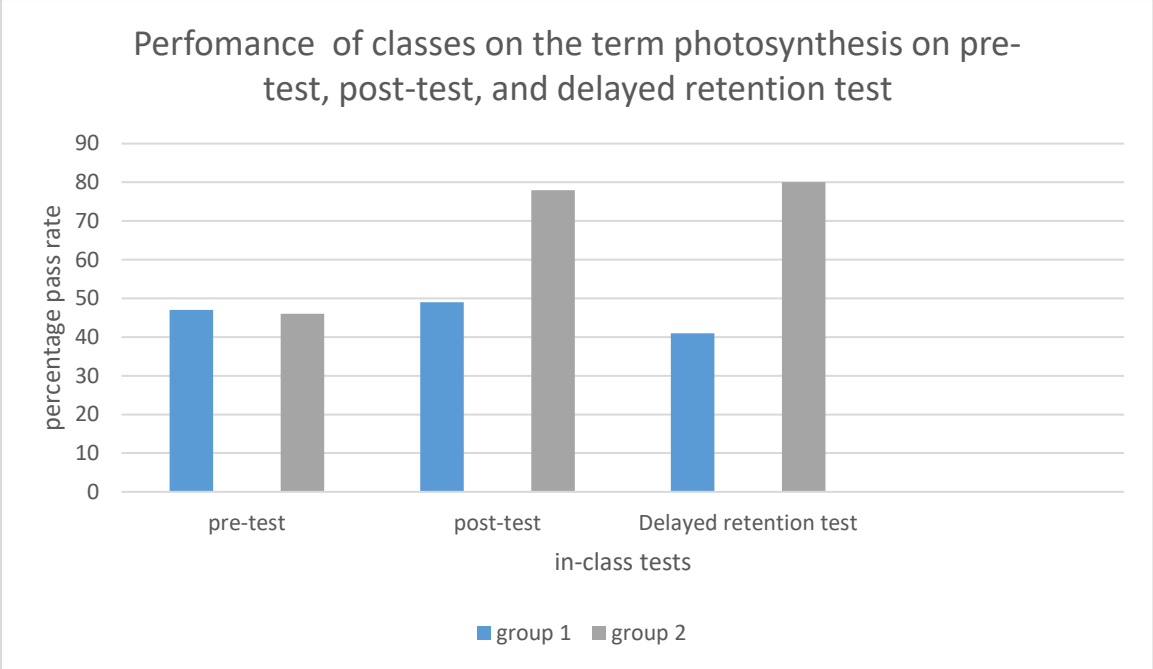

Fig 4.1: Average class performance on the definition of photosynthesis on pre-test, post tests and delayed retention test

As shown in the figure 4.1, both groups failed to perform well on question one of the pre-test. The average marks for group 1 on this question was 45% and 46% for group two. After different instructional methods were used to teach photosynthesis, a post-test was given to the classes and the average pass rate for both groups in the post test changed. For group 2 where practical work method was used the results show a significant rise from 46% to 78%. This is consistence with Haynie (1997) that no science can be properly taught without student experiments and these experiments should be the central part of science teaching because they are performed to find relations among concepts and to verify hypothesis.

For group 1 where the lecture method was used the results show a slight increase from 47% to 49%. After a period of thirty days a delayed retention test was administered to both classes and the following results were obtained. In group 1 there was a sharp decrease from 49% to 41%. A continuous increase in percentage pass rate from 78% to 80% was noticed in group 2. This is consistence with Beydogan (2001) that students have more time and opportunities for hands-on experience, active thinking and knowledge reflection. According to this study's results, retention or remembrance level in lesson through practical work was higher than in group 1where lecture method was used Because, people remember 10% of what they read, 20% of

what they heard, 30% of what they saw and 90% of what they had a hands-on experience (Sinclair, 2004). According to research results it shows that there is a positive correlation between practical work and academic attainment of most learners who learn the concept of photosynthesis through practical work. The findings are in harmony with previous studies by Hofstein and Innetta (1982) who mentioned that laboratory work plays an important role in science education.

4.5.2 Describing the test for gas produced during photosynthesis

The question required the pupils to describe the test for gas produced during photosynthesis. The average group performances for the question in pre-test, post-test and delayed retention test after 30 days were as shown on fig 4.2 below

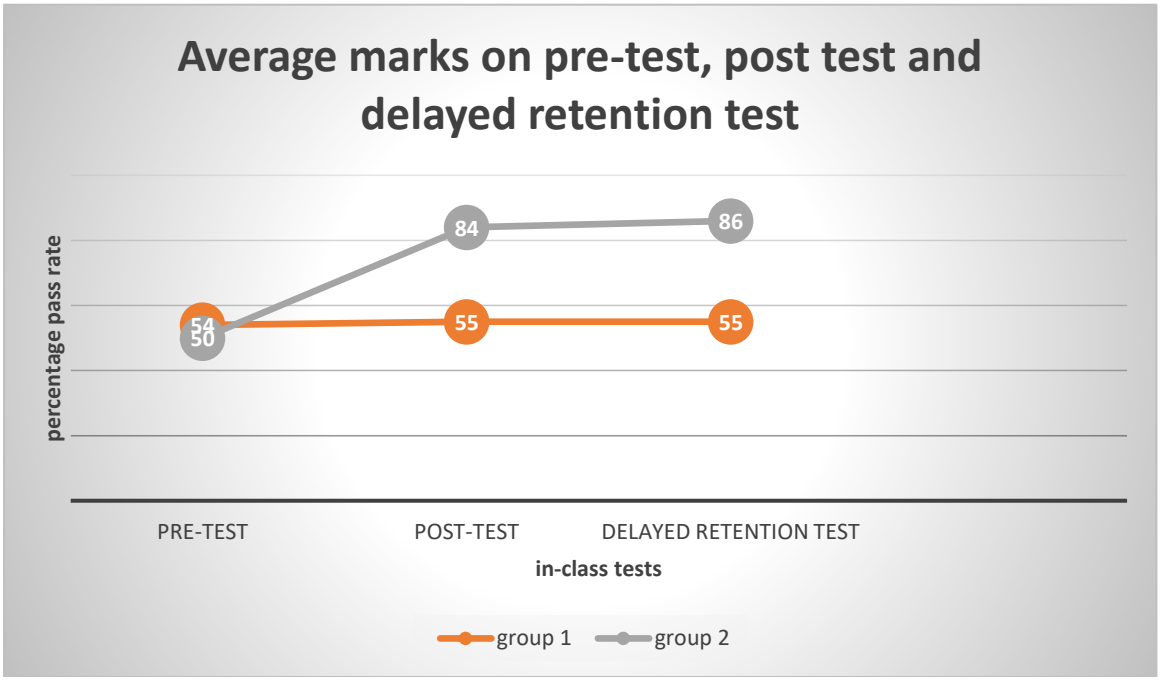

Fig 4.2: Results on gas produced during photosynthesis

As shown in fig 4.2 above the general performance of both classes was at average in pre-test. After the application of different teaching method in the teaching of photosynthesis, the results of post-test shows a rapid increase in pass rate of group 2 from 50% to 80%, while in group 1 the percentage pass rate just increase by 1%. This is consistence withFisher et al (1998) that practical work are a central theme of lessons in the sciences and are seen as integral part in Biology and offer students a learning environment that differs in many ways from the "traditional" classroom setting. Results from delayed retention test reflect that there was no change in average marks of group 1 while a consistent increase from 84% to 86% was noticed in group 2 where practical work method was used. From the findings it is evident that practical activity have a great influence on learners development of biology skills and hence the application of such skills. As Gututhu (2014) contents, new concepts are taught and introduced which ultimately make the learning process to be inquiry oriented. Practical activities being real, provide an opportunity to link the practical aspects to the theory.

This makes learners have confidence in some of the theoretical content and aspects that they go through during learning while in school. In so doing the learners are able to appreciate that Biology as a science works. This is similar from the findings by Hodson (1990) that practical

work enhance the learning of scientific knowledge to the learners and widen their way of thinking.

4.5.3 Reasons for destarching a leaf before setting up some photosynthesis experiments

The figure 4.3 below gives the average marks of both classes on question 3 of the pre and post tests and delayed retention test. The learners were asked to give reasons on why a leaf is destarched before the experiment on photosynthesis.

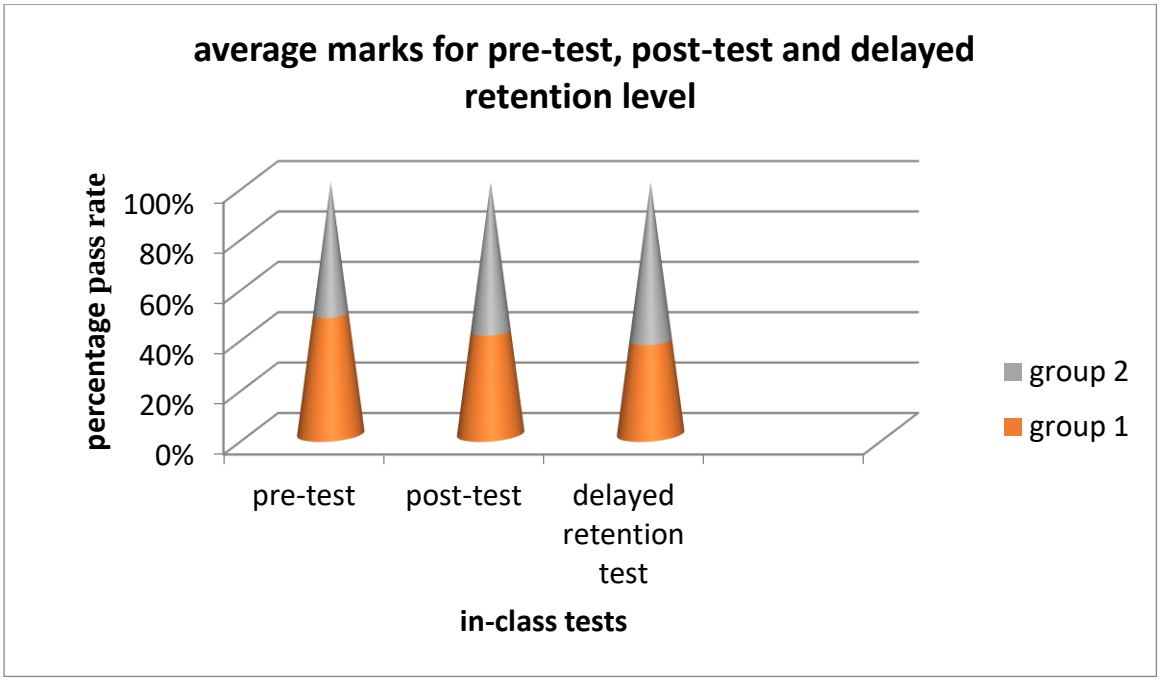

Fig4.3 Results on reasons to destarch a leaf before setting up some photosynthesis experiments

As indicated in fig 4.3 above, group 2 recorded better average marks of 54% as compared to group 1 with 49%. After the application of different teaching method to taught photosynthesis, there was a significant increase of average marks from54% to 71% in group 2 where the practical work method was used. This suggest that practicals yield better results in biology. This is in harmony with Gituthu (2014) who posited that a well planned practical work can stimulate and engage students' learning at different levels, challenging them mentally and physically in ways that other science have been observed to have higher academic attainment than those taught via the expository approaches. Results also shows that there was no change in average marks in group 1 where the lecture method was used.

Results of delayed retention test indicated that there was a slight fall in average pass rate in group 1 where lecture method was used. However a continuous increase in percentage pass rate was noticed in group 2. From the findings of this study, it showed that academic performance of learners is improved when they learn through practical work. This is similar to the findings by Fadzil and Saat (2013) who stressed that practical work confers many advantages including developing laboratory skills and scientific knowledge as well as understanding science concepts and theories. Practical work has been able to promote learners' positive attitudes and enhance motivation for effective learning in science as described by Okam and Zakari (2017).

4.5.4 Factors affecting the rate of photosynthesis

The question demands the learners to simply describe factors affecting the rate of photosynthesis. The average class scores for both groups on question 4 were as shown in figure 4.4 below

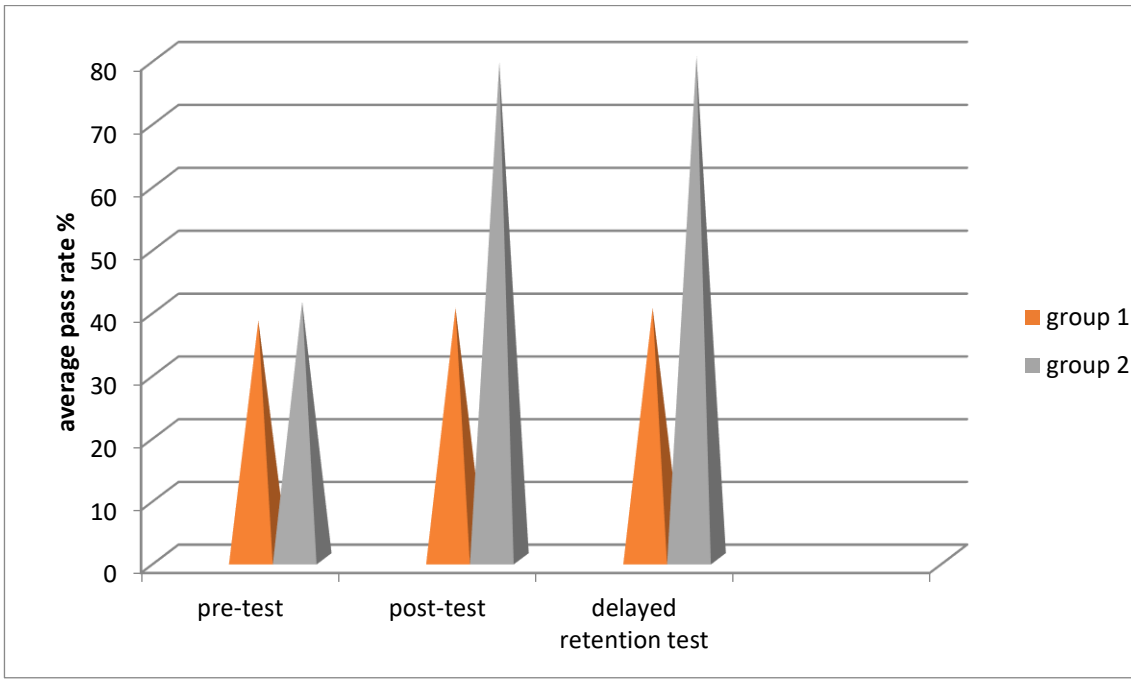

Figure 4.4: Average marks on factors affecting the rate of photosynthesis

As shown on fig 4.4 above the control (group 2) scored 41% in the pre-test and 79% in the post test and 80% in delayed retention test. Judging from the statistics given, one can note that there was a marked progress in the general performance of the control group after the application of practical work method. The sentiments were in harmony with Okam and Zakari (2017) that practical activity is the most preferred learning strategy which yield better results. The results also indicated that group 1 scored an average marks of 38% in pre-test, 40% in post-test and 40% in delayed retention test. This suggests that there was no progress in general performance of the students where lecture method was used. This is consistence with Jacobs et al (2002) research which has shown that retention and recalling of what was learned is linked to experimental experience.

He emphasised that learners will remember 90% of what was said and done. Meaning

to say only 10% is remembered when lecture method is used. Accordingly, the research results shows that there is a positive correlation between practical work and academic attainment of most learners who learn the concept of photosynthesis through practical work. The findings are in harmony with previous studies by Hofstein and Innetta (1982) who mentioned that laboratory work plays an important role in science education.

4.5.5 Importance of photosynthesis

The question requires learners to give reasons on why photosynthesis is importance to biodiversity and ecosystem. The average scores obtained by learners were shown on figure 4.5 below

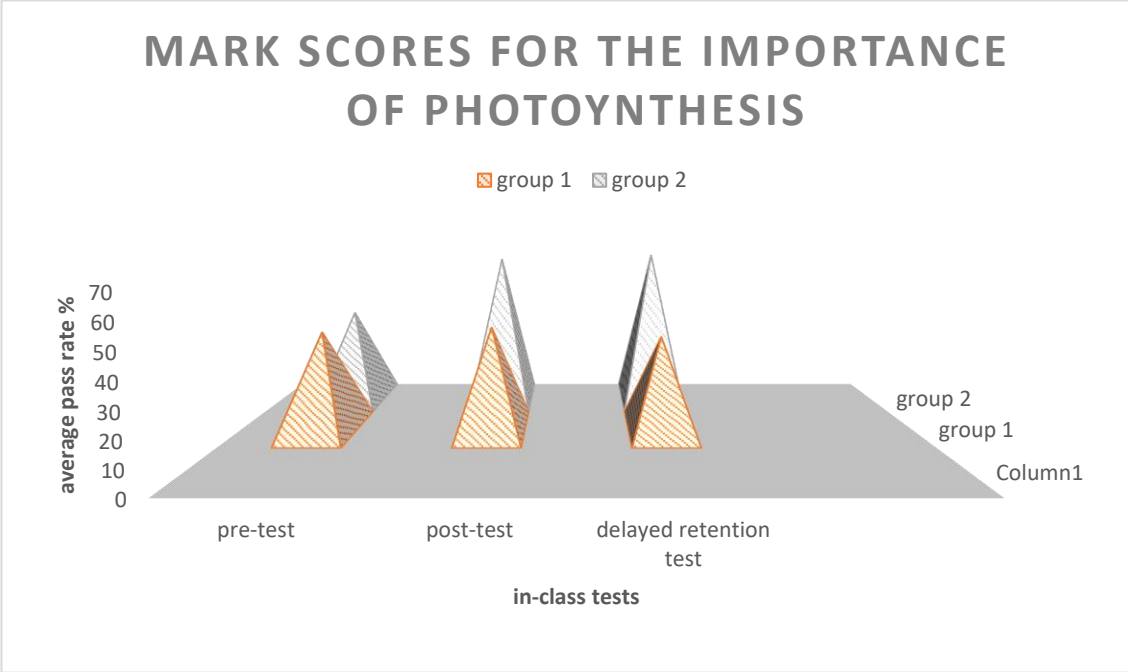

Fig 4.5 : Results on the importance of photosynthesis

As shown in fig 4.5 above, in the pre-test average class pass rate for both groups was the same. After the topic photosynthesis was taught to the control (group 2) through practical work method, the post-test average marks for group 2 rose to 68% and for group 1 the average marks just rose by a margin of 2% that is from 42% to 44%.

After a period of thirty days average pass rate in group 1 show a decrease from 44% to 40% while a continuous improvement has been noticed in group 2 where the average pass rate rose from 68% to 70%. This suggest that practicals yield better results in

Biology.This is in harmony with Gituthu (2014) who posited that a well planned practical work can stimulate and engage students' learning at different levels, challenging them mentally and physically in ways that other science have been observed to have higher academic attainment than those taught via the expository approaches. This is consistence with Wright (2006) who holds the view that the use of experiments creates confidence in one's own abilities and is very effective in science teaching because it leaves learners to find out knowledge on their own and in their own ways but under the teacher's guidance. The findings also shows that, there was no change in average marks in group 1 where the lecture method was used. This is consistence with Jacobs et al (2002) research which has shown that retention and recalling of what was learned is linked to experimental experience. He emphasised that learners will remember 90% of what was said and done. Meaning to say only 10% is remembered when lecture method is used.

4.5.6 Leaf adaptation for photosynthesis

The question required respondents to identify the main features that allow leaves to carry out photosynthesis and give reasons on how those features aid in food production.

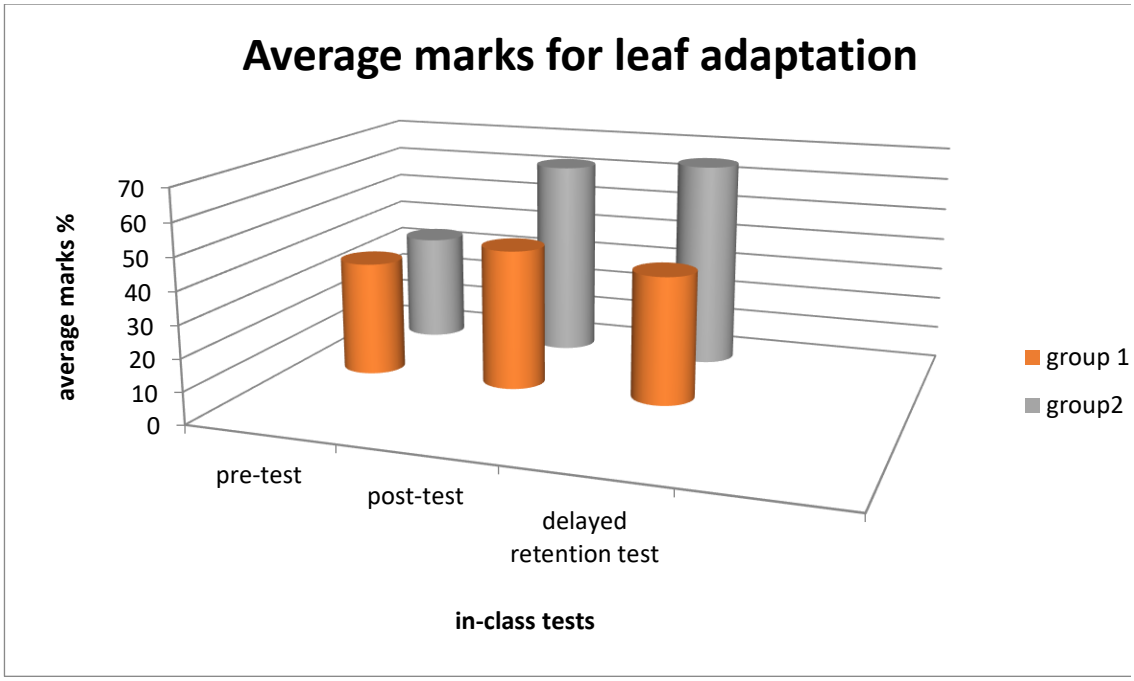

Fig 4.6: Average class marks for leaf adaptation for photosynthesis

The fig 4.6 above shows the average marks for pre-test, post-test and delayed retention test for both groups. In the pre-test group 1 had an average of 36% which was greater as compared to group 2 with 34%. After the application, practical work method in group 2, the results of the post-test indicated a remarked improvement from 34% to 62%. Practical work has also been shown in some studies to help improve the communication skills of learners in order to solve problems in science and thus become more motivated in science (Woolnough, 1994). This is consistence with Ernersto (2005) who reiterate that the use of practical work method encourage learners to follow procedures carefully and promote students to perform experiments, record observation and summarise data and draw conclusion. Practical work usually implies learning by doing. A slight increase from 36% to 40% was also noticed in group 1 after the application of lecture method. Results from delayed retention test shows a continuous improvement from 62% to 65% in group 2 while a slight fall was recorded in group1.

This is in harmony with Buttner (2000) who stressed that teaching photosynthesis through practical work method is in fact a powerful ally in the task of forming, educating and transmitting contents and attitudes, like those that are present in the science

domains.

4.5.7 Overall class averages for the pre, post tests and delayed retention test

Having looked at the questions of the pre-test, post-tests and delayed retention test individually, figure 4.7 presents the average class marks for all the questions in the pre and post-tests and delayed retention test.

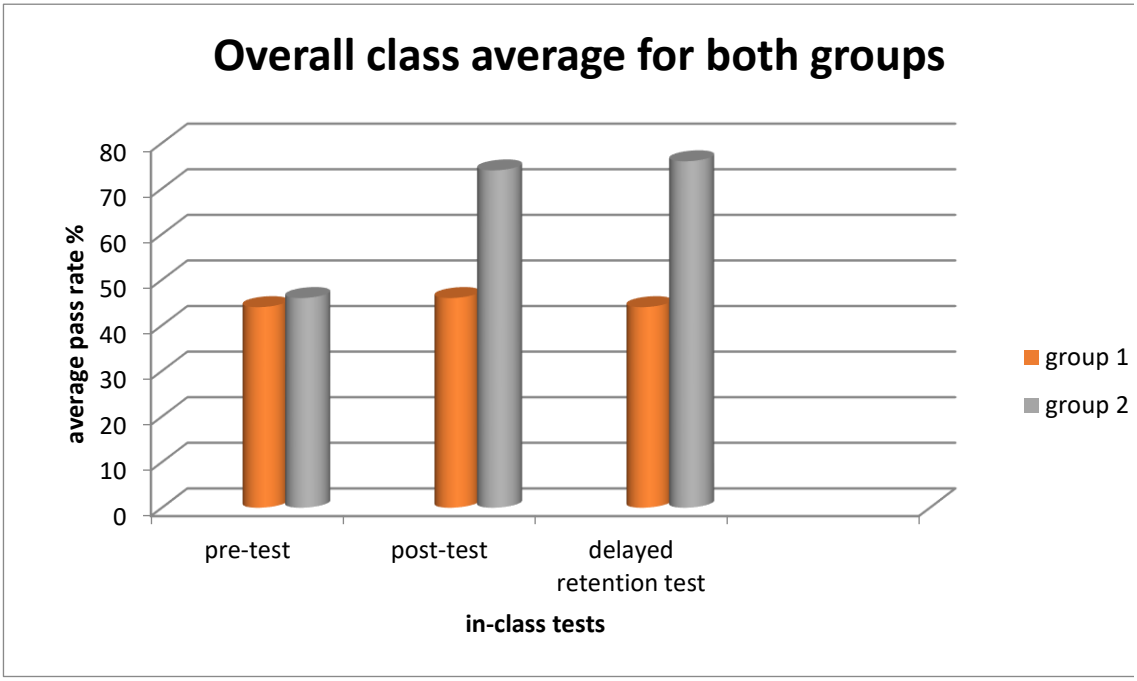

Fig 4.7: Overall Class averages for the pre-test, post-test and delayed retention test

As given in the figure 4.7 above group 1 had average marks of 44% in the pre-tests while group 2 had an average score of 46%. However after teaching photosynthesis through practical work method the overall class averages rose to 74% for group 2.

This is consistence with Wright (2006) that the use of practical work method creates confidence in pupils abilities and is very effective in science teaching because it leaves learners to find out knowledge on their own and in their own ways but under the teacher's guidance. In group 1 there was a slight increase from 44% to 46%. These

differences in the increases of class averages with higher percentages (28%) in group 2 and a slight fall in average scores in group 1 shows the effectiveness of practical work method in the teaching of photosynthesis. This is similar from the findings by Hodson (1990) that practical work enhance the learning of scientific knowledge to the learners and widen their way of thinking. This is consistence to Jacobs et al (2002) that retention and recalling of what was learned is linked to practical experience. He emphasised that learners will remember 90% of what was said and done. According to research results it shows that there is a positive correlation between practical work and academic attainment of most learners who learn the concept of photosynthesis through practical work. The findings are in harmony with previous studies by Hofstein and Innetta (1982) who mentioned that laboratory work plays an important role in science education.

4.6Summary

The chapter has presented and analysed data collected in the form of tables, graphs and charts. The researcher is contended that the above analysed data is enough to make conclusions and recommendation in the next chapter.

CHAPTER FIVE
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter summarizes the previous chapters on introduction, literature review, research methodology and research findings and analysis. It also focuses on the summary, conclusions and recommendations on the effectiveness of teaching photosynthesis through practical work at 'O' level Biology. The thrust of this chapter is a summary of the main findings facilitating the drawing up of a conclusion of the entire research project.

5.1 Summary

The aim of the study was to investigate the effectiveness of practical work method in the teaching of photosynthesis. Chapter 1 set out the introduction of the study through a description of background, statement of the problem, research objectives, research questions, significance of the study, limitations, delimitations, assumptions and conclude by giving definitions of important terms in the study. The aim of this chapter was to give readers background understanding of the research problem. This chapter gives an overview of the study. The effectiveness of using practical work in the teaching of photosynthesis was explained. Emphasis was placed on practical work as an instructional method that gives learners a room to gain confident, scientific attitude and skills through investigation process.

The principal role of chapter 2 was to examine previous theoretical and practical studies

concerning practical work as effective instructional method. The chapter identify gaps between existing literature and the current research topic and establish the means through which knowledge gaps can be filled. Also included in this chapter is the theoretical framework of the study. The study is based on the theory of constructivism. Constructivists view learning as an active process whereby learners should learn to discover principles, concepts and facts for themselves. The chapter also focused on the history of practical work and other teaching methods. Also included in this chapter are the benefits of practical work in the teaching of photosynthesis at form 4 Biology as well as the major constrains towards the use of practical work. The reasons behind the failure to use practical work when teaching photosynthesis include: problem of large classes, learners' and teachers' attitude, poor laboratory conditions, time frame, syllabus coverage and pedagogical content of the teacher.

The principal role of chapter 3 was to give a detailed description of research design employed to provide the overall strategy for answering the research questions for this project. It highlighted tools and techniques used in primary data collection. The study was guided by both qualitative and quantitative paradigm. Qualitative data were obtained through a questionnaire as research instrument, while quantitative data was obtained through pre-test, post-test and delayed retention test as research instruments. The population of this study was taken from all form 4 learners taking Biology at Gambuli secondary school. Stratified simple random sampling was used to select a sample a 40 form 4 Biology learners from the population. Purposive sampling was used to select 4 Biology teachers to answer the questionnaire.

The principal role of chapter 4 was to present the results from the study. The scores from the pre-test, post-test and delayed retention test were analysed to find out if there was any statistically significance difference in the performance of learners. The results were linked with

literature review. The responses on the questionnaire were used to explain the qualitative results. The analysis of the tests produced data that was used to ascertain the effectiveness of practical work in teaching photosynthesis. The chapter present a detailed analysis of the research findings through the use of statistical descriptions involving the construction of tables, graphs and pie charts. The findings obtained were linked to the research questions, objectives of the study and used to draw conclusion.

The principal role of chapter 5 is to summarizes the previous chapters on introduction, literature review, research methodology, research findings and analysis. It also focuses on the summary, conclusion and recommendations on the effectiveness of teaching photosynthesis through practical work at form 4 Biology. The thrust of this chapter was a summary of the main findings facilitating the drawing up of a conclusion of the entire project. The major findings of this research is that, practical work method has been effective in teaching photosynthesis at Gambuli secondary school.

5.2.1 Conclusions

The findings of this study indicate the effectiveness of practical work in the teaching of photosynthesis at Gambuli secondary school. The research also indicated that there have been several advantages on practical work method in the teaching of photosynthesis.

Some of the benefits of practical work include; stimulates creativity, curiosity and critical thinking, encourages active learning and problem solving as well as allow collaborative learning. The research finds out that practical work method allows students to perform experiments, records observations and results, summarise data and draw conclusion. The findings show that the use of effective practical activities helps to improve the students' attitude

towards Biology. It helped improve their interest, understanding, motivation and ultimately their achievement. A significant positive relationship was discovered between learners' attitude and their achievement. The results of this study clearly show that students having a more positive attitude towards their lesson are found to be better achievers.

The research finds out that practical work method fosters opportunity for the acquisition of meaningful learning of the concept to the point of achieving transfer and application of knowledge. Hence help students to develop attitudes and skills of a scientist such as enquiry, curiosity, carefulness, objectivity and honesty.

The research also finds out that there are challenges that teachers face in the application of practical work method. The challenges include existence of large classes and limited of materials and equipment. The researcher also gathered from the data that practical work method delay progress in syllabus coverage. The research also gathered from the data collected from in-class tests that practical work is an effective method in the teaching photosynthesis. The results shows that, retention level in treatment group was higher as compared to the control group.

5.2.2 Biology teachers' perception of the importance of practical work

The findings of this study indicate that practical work has a significant effect on improving learners' attitude towards Biology. According to results extracted from teachers' perception of the importance of practical work, practical work has been able to promote learners' positive attitude and enhance motivation for effective learning in science as described by Okam and Zakari (2017). The majority of teachers indicated that practicals were necessary in the teaching

of Biology because practicals proved theory in Biology and made Biology an interesting subject. This is consistence with Maduabum (2000) who points out that, the use of experiments enable students to have direct sensory experience of scientific knowledge for example working with living organism such as green plants it embrace the learner not only to acquire knowledge but also to appreciate life., He further insisted that, using practical method in the teaching of photosynthesis at 'O' level Biology fosters opportunity for the acquisition of meaningful learning of the concept to the point of achieving transfer and application of knowledge. Hence help students to develop attitudes and skills of a scientist such as enquiry, curiosity, carefulness, objectivity and honesty.

Also indicated by Biology teachers is that practicals promote learners' understanding of the topics better, and also stimulated students' interest in Biology. This is consistence with Ernersto (2005) who reiterate that the use of experiments encourage students to follow procedures carefully and promote students to perform experiments, record observation and summarise data and draw conclusion. Practical approach usually implies learning by doing. Practicals developed learners' skills on handling and organizing apparatus and materials and in following given instructions.

Therefore, practical work can motivate learners by stimulating interest and enjoyment, used to teach laboratory skills, enhance the learning of scientific knowledge, give insights in to the scientific method and develop expertise in using it and, develop scientific attitudes such as open mindedness and objectivity (Hodson, 1990).

Biology teachers also indicated that practicals allowed learners to learn better when they saw and touched objects, they do not forget what they have seen and this reinforces their content grasp. This is consistence with Jacobs et al (2002) research which has shown that retention and

recalling of what was learned is linked to experimental experience. He emphasised that learners will remember 90% of what was said and done. Practicals yield better results in Biology and prepared learners to answer questions in Paper 3 during ZIMSEC exam. This is consistence with Wright (2006) who holds the view that the use of experiments creates confidence in one's own abilities and is very effective in science teaching because it leaves learners to find out knowledge on their own and in their own ways but under the teacher's guidance.

From the teachers' responses, it was clear that all 3 Biology the teachers were aware what practical work was all about and why it was necessary in the teaching of Biology. As indicated by Clackson & Wright (1992), Gott & Duggan (1995), and Leach (1999), a teacher's belief or conception of practical work can impact directly on the way she/he arranges practical work. Teachers should therefore have a clear understanding of what practical work entails and the purposes it serves. Having a clear understanding about the nature of practical work might help the teachers to plan teachable practical activities.

Teachers were also asked whether lack of a Biology laboratory would prevent them from doing practical work in Biology. The majority of the teachers indicated that not having a laboratory could not prevent them from carrying out practicals in Biology, while the minority of the teachers said that if there was no laboratory at school then they would not be able to carry out practical work in Biology and thus were not carrying out the practicals. The teachers, who indicated that if the school did not have a Biology laboratory, then they would not carry out practical work with their learners, explained that "classrooms were not conducive for conducting practicals, as some practicals were dangerous to be carried out in the classrooms".

The majority of teachers who indicated that lack of a laboratory would not prevent them from carrying out practicals in Biology explained that "if there was no laboratory at school, then one should use the classroom or the outside to conduct the practicals" Whether the school has a laboratory or not, learners will still write Paper 3 examinations at the end of the year. Accordingly, teachers need to expose learners to practical work if they are to do better in Paper 3. This implies that learners must be exposed to practical work and demonstrations. If learners are not exposed to practical work, due to the lack of a laboratory for example, they might not be able to answer questions on Paper 3 and this in return might affect their final performance in Biology.

5.2.3 Is there any statistically difference between academic attainment of form 4 Biology learners taught using practical activities and those taught using lecture method

The finding from this study revealed that there was a statistically significant difference in the performance of learners. The quantitative results show that learners performed better in the post-test and delayed retention test after using practical work. There was an increase in the percentage of learners who passed the post-test and delayed retention test as compared to those who passed the pre-test. According to the research results, it shows that there is a positive correlation between practical work and academic attainment of most learners who learn the concept of photosynthesis through practical work.

The findings are in harmony with previous studies by Hofstein and Lunnetta (1982) who mentioned that laboratory work plays an important role in science education and also helps in understanding the difference between observation and presentation of data.

The results shows that retention level in treatment group was higher in treatment group where practical work was used as compared to the control group where lecture method was used. From the findings of this study, it is evident that academic performance of learners is improved when they learn through practical work. This is similar to the findings by Fadzil and Saat (2013) who stressed that practical work confers many advantages including developing laboratory skills and scientific knowledge as well as understanding science concepts and theories.

The findings of this study also shows that there was a slight change in average marks in control group where lecture method was used. This is consistence with Jacobs et al (2002) research which has shown that retention and recalling of what was learned is linked to experimental experience. He emphasised that learners will remember 90% of what was said and done. Meaning to say only 10% is remembered when lecture method is used.

5.2.4 Ways of improving the teaching of photosynthesis through practical work

Various ways can be done to improve the effectiveness of practical work in the teaching of photosynthesis at Gambuli secondary school. These include the provision of standard laboratory and adequate laboratory equipments. There is need for teachers to make sure that materials are available and improvise where possible.

This is in harmony with Balman (2003) that, the availability, reliability and condition of the equipment are considered before conducting practical activitity. There is need for learners to be allowed access to laboratory equipments so as to familiarise with them. There is need for teachers to assemble in advance all the necessary materials and equipment to be used for practicals and budget their time well. Preparation of materials in advance saves time and allow experiments to be successful.

Enough biology teachers should be employed to cater for increased population of learners and deal with the problem of large classes. There is need for teachers to improve their teaching methodology to sustain the interest of learners. This is consistence with Haynie (1997) that no science can be properly taught without experiments and these experiments should be part of

science teaching because they are performed to find relations among concepts and to verify hypothesis. There is need for training and workshops for teachers which emphasize on the use of practical work methods and how they can be improved to enhance learners' performance. This is in harmony with Killerman (1998) that is important to consider whether learning is more effective if learners are to do experiments themselves or they watch the teacher demonstrating the experiments and simply describing the experiments to the learners and tell them the results.

5.3.0 Major constrains towards the use of practical work

The reasons behind the failure to use practical work in the teaching of photosynthesis include problem of large classes, learners' and teachers' attitude, poor laboratory conditions, time frame, syllabus coverage and pedagogical content of the teacher.

5.3.1 Problems of large classes

Lack of qualified biology teachers is one of the drawback towards the use of practical work in teaching of photosynthesis at 'o' level Biology. As a result of this shortage most teachers have to teach more than the required number of learners. Dormer (2000) points out that, there are significant problems associated with teaching the practical aspects of photosynthesis. In large classes, learning outcomes are affected by the quality of demonstration and success of particular experiment. This can result in variability within and between practical classes, in any cohort which has any implication for equity and well as for learning outcomes generally. Jeanne (2003) articulates that smaller classes benefit all pupils because of individual attention from

the teacher.

Newkirk (2005) stress that student achievement increases significantly in classes of fewer than 20.Smaller classes, completed by diverse teaching methods create better student performance, more positive attitudes and fewer discipline problems. Pupils in large classes drift off the task because of too much instruction from the teacher to the whole class instead of individual attention. According to Weimer (2013) student –teacher ratio is the number of students who attend school divided by the number of teachers. For example, a student- teacher ratio of 10:1 indicates 10 students for 1 teacher.

Martin (2004) states that class size reduction show more positive teacher-student interactions leading to less time spent on discipline. According to Beakes (2007) smaller classes allow for potential disciplinary problems to be identified and resolved more quickly. According to Bracey (2005) effective learning demands opportunities for students to become actively involved in their education.

Teachers are demanded to play roles such as facilitator, enabler not only as lecturer and transmitter of knowledge. These opportunities and roles cannot be achieved when teachers are faced with large classes and heavy workloads. Rose (2006) states that the larger the number of students in a class, the greater the amount of time devoted to classroom management rather than instruction. A teacher who faces 25 students in a class period of 50 minutes has no more than 2 minutes, at best per pupil for one to one interaction during any period.

5.3.2 Non availability of laboratory equipment

Bulman (2003) points out that, the availability; reliability and condition of the equipment are considered before conducting practical approach. The physical facilities available must also be

borne in mind such as availability of electricity. Lederman (1997) insisted that, laboratory exercise are available but revolve equipment and procedures that are unreliable and prohibitively expensive are questionable. Hence financial constraints may impede conducting experiments on photosynthesis. Moss (2001) points out that science teachers often try to teach students about scientific principles through the use of lab experiments, though they do not always have access to the resources needed to optimally perform experiments. Kolb (1997) emphasized that in a science classroom, teachers may not be able to access everything that they need in order to deliver effective instruction. Schools often run short of important items like science equipment because they have been lost, were never ordered, are broken or are just too expensive to purchase (Mutasa and Wills, 1995).

5.3.3 Learners and teachers attitudes

According to Rajan (2002) teachers and learners attitude have a great implications on learners performance in the teaching of photosynthesis through practical work. Teachers' approach in the teaching of photosynthesis through practical work has effects on learners' attitude towards the topic photosynthesis. A situation where the teacher monopolises the teaching and learning process of photosynthesis with less participation of learners could result in apparent lack of interest in the topic hence poor performance.

5.3.4 Time frame

Bell and Beverly (2000) reviewed that, they are some very elegant experiments and procedures that are often slow and require precision to gain meaningful results for example gas exchange for classic elodea experiment. Significantly if students are unclear about the

principles before the practical and take insufficient care in collecting the data, they may gather data that is inconsistent with the theoretical expectation, rather than clarifying concepts this will merely reinforce misconception.

Lederman (1997) postulated that for a Biology teacher to carry out effective Biology practicals in the Laboratory, careful planning and proper organization are necessary. To this effect, he/she needs to assemble in advance all the equipment and materials for the exercise. Furthermore, he/she has to ensure that they are also in good working condition. Subsequently, the experiment is trial tested by carrying it out first to ensure that the chemicals to be used are still very active and the procedure carefully followed by the teacher.

Haya (2001) propounds that pre-laboratory session is very important because it reduces errors which the teacher may have committed in the actual laboratory session. Also the sitting arrangements of students are put into consideration as well as the time to spend in carrying out the investigation.

5.3.5 Pedagogical content knowledge of the teacher

Gwarinda (1995) points out that the two main methods are teacher centred and child centred approach. In the teacher centred approach, the teacher concentrates on fully giving information to the learner. It is assumed that the teacher knows the best and hence directs all learning. The teaching dominates over learning and pupils are assumed as empty vessels into which information is to be poured. Bell (2000) expressed that new methods and techniques are being employed in the teaching of science. It is therefore desirable that biology teachers are trained and well versed in knowledge of preserving specimens and animals, techniques of evaluation and lesson unit planning. Hence if the pedagogical content knowledge background of the teacher is poor, other instructional methods may be used in place of experimental approach

such as lecture method which does not expose students to greater learning opportunity by doing it.

Weinstein (2003) points out that the teacher should have knowledge of the science and behavior of his students in order to handle them effectively in the teaching- learning process. He/she should try to impart knowledge and skills to then according of their mental abilities, capacities, interests and attitudes, as well as emotional and social make up. Martin (2004) proclaims that if the teacher is well equipped he/she may help the students to undergo a battery of intelligence tests a science stream of the curriculum.

In this way, if scientific knowledge is imparted to the deserving students it will make the tasks of the teacher and the taught easier. Jeanne (2009) emphasized that the knowledge of other tests and psychological measurement will help the teacher to understand the ability, and behavior potential of the child at the different stages of learning or development and consequently bring changes in mode of behavior and methods of teaching. Hayo (2007) reiterates that it is also essential for a science teacher for being trained in the latest techniques, strategies and methodology of teaching science including the use of the all type of aid material and developed technology.

5.3.6 Poor laboratory conditions

According to Dormer (2002) biology laboratories should possess the following features for effective learning of photosynthesis through practical work. A fairly large room with demonstration and preparatory room and the stores. Long tables with sinks, four way type of gas points, two reagents shelves, water supply taps and drawers, gas chamber, fume cupboard, refrigerator and air conditioners, raised plat-forms and safety devices. However

most of our secondary school laboratories fall short of this standard and hence provide a negative impact on learners (Martin, 2004).

5.3.7 Syllabus coverage

Rajan (2002) points out that in terms of syllabus coverage, practical approach does not lend itself to easy coverage of the syllabus. This is because concepts and theories that can be described and explained in five minutes may take one hour to investigate and clarify the hypothesis. It is often very difficult to design a really good experiment. Lederman (1997) proclaims that it can take a scientist several months or years to design a good experiment that that prove hypothesis.

5.4.0 Recommendations

Therefore, the recommendations of this study are as follows:

- There is need for staff development programs so as to upgrade the pedagogical content of teachers and encourage them to make use of practical work method to teach photosynthesis, this is consistence with Haynie (1997) that no science can be properly taught without student experiments and these experiments should be the central part of science teaching because they are performed to find relations among concepts and to verify hypothesis.
- There is need for better ways and strategies of managing and improving practical work in the teaching of photosynthesis.
- Teachers should plan their lessons in a more practical way to enhance learners' attitude as well as achievement.

- There is need for training and workshops for teachers which emphasize on the use of practical work methods and how they can be improved to enhance student's performance, this is consistence with Killermann (1998) that it is important to consider whether learning is more effective if the students do the experiments themselves or they watch the teacher demonstrating the experiments and simply describing the experiments to the students and telling them the results.
- There is need for teachers to assemble in advance all the necessary materials and equipment to be used for practicals and budget their time well.
- There is need for teachers to make sure that materials and improvise where possible this is consistence with Balman (2003) that, the availability; reliability and condition of the equipment are considered before conducting practical approach.

- The way teachers train should be changed and should make it active in teachers college.
- More attention and consideration should be given to practical teaching in secondary schools.
- There is an urgent need to re-think and re-focus current state of practical teaching in a way that enables effective teaching.
- Practical activities should be well planned, effectively conducted and made an integral part of the pedagogy.
- Additional resources for fully furnishing the laboratories, buying inputs and training should be made available.
- The school administration, teachers, relevant government bodies, NGOs and the community should work closely to make sure that the practical work is conducted effectively.

- Provision of standard laboratory and adequate laboratory equipments for secondary schools.
- Teachers should improve their teaching methodology to sustain the interest of the students.
- Enough qualified Biology teachers should be employed to cater for increase population of students.
- Students should be allowed access to laboratory equipments
- The administration of schools should supply their schools with all necessary equipment and chemicals needed to facilitate practical work in the teaching of photosynthesis.

5.4.1 Recommendations for further study

- Further research study needs to undertake a deeper analysis on the extent to which practical work method can be improved as a result of adequate supply of science materials and reduce the existence of large classes, so that the findings of this research can be authenticated.
- More research is needed to simplify the teaching of photosynthesis through practical work and make Biology easier and more exciting subject.
- Further studies should be undertaken to explore the use information and communication technology (ICT) in the teaching of photosynthesis through practical work.
- Further studies should examine the impact of learner centred activity on the efficacy of practical work which can give room for learners to design their own experiments.

- There is need to conduct a countrywide study that will shed more light on why Biology teachers are reluctant to conduct practical work at secondary school level.

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APPENDIX A

REQUEST TO CONDUCT A RESEARCH

GAMBULI SECONDARY SCHOOL

P O BOX 42
CHINHOYI

REF: REQUEST TO CONDUCT A RESEARCH STUDY

Dear Sir or Madam:

I am a second year HBScEdBz student with Bindura University. I am seeking permission to undertake a research project entitled effectiveness of teaching photosynthesis through practical work.

Information gathered from your organisation will be used strictly for academic purposes only. The findings will be presented to you for verification if need be.

Your response at its earliest convenience would be greatly appreciated.

Yours faithfully

Takaendesa Kedy

APPENDIX B PRE-TEST

REVISION TEST: PHOTOSYNTHESIS

INSTRUCTIONS : ANSWER ALL QUESTIONS

i. Photosynthesis is the process by which green plants manufacture----------. A green pigment called----------found in plants is essential for this process. This green pigment is found in the----------. [3]

ii. Name the gas produced during photosynthesis and describe how it is tested? [2]

iii. What is meant by destarching a leaf and describe why is it necessary to destarch a leaf before setting up some photosynthesis experiments [2]

iv. Describe five factors affecting photosynthesis [10]

v. Explain the importance of photosynthesis [3]

vi. Explain how leaves are adapted for photosynthesis [10]

[TOTAL 30 MARKS

APPENDIX C POST-TEST

REVISION TEST : PHOTOSYNTHESIS

INSTRUCTIONS : ANSWER ALL QUESTIONS

i. Define the term photosynthesis [3]

ii. (a)Name the end product of photosynthesis tested by a glowing splint and (b)describe what happens to the glowing splint if the product is present [2]

iii. Describe how a leaf is treated before setting up photosynthesis experiments? [2]

iv. Explain the following factors of photosynthesis

a) Temperature
b) Water
c) Carbon dioxide concentration
d) Chlorophyll
e) Light intensity [10]

v What are the importance of plants [3]

vi Explain the following leaf features in relation to photosynthesis

a) Thin leaves
b) Broad and flat leaves
c) Many stomatas
d) More chloroplasts
e) Large number of veins [10]

[TOTAL = 30 MARKS]

APPENDIX D DELAYED RETENTION TEST

REVISION TEST : PHOTOSYNTHESIS

INSTRUCTIONS : ANSWER ALL QUESTIONS

i. (a)Name the process which remove carbon dioxide from the atmosphere and (b)define the process named above [3]

ii. Describe the test for oxygen [2]

iii. Explain why a leaf is placed in dark place for 24-48hrs before setting up for some photosynthesis experiments [2]

iv. Explain the factors affecting photosynthesis [10]

v. Besides binding the soil what other roles of plants in our lives [3]

vi. Explain how leaves are adapted to photosynthesis [10]

[TOTAL = 30 MARKS]

APPENDIX E: Questionnaire for Gambuli biology teachers

My name is Takaendesa Kedy. I am a student at Bindura University of Science Education undergoing a degree in Bachelor of Science Education (Honours) in Biology. I am carrying out a research on the effectiveness of teaching photosynthesis through practical work at 'o' level biology. Instructions in this questionnaire is designed with the aim of investigating the views and attitudes of Biology teachers towards practical work at Gambuli secondary school. The information to be collected from these questions will be used to understand the way in which practical work is conducted at Gambuli Secondary school and how such practices may affect students' performance in Biology. Your honest responses will help in improving the way in which practical work is conducted in our secondary schools. Please do not write your name on any part of this questionnaire. Thank you for your answers which will contribute to making our schools offer effective instructions to our learners in Biology.

Note: The information provided is strictly for academic purposes and shall be kept confidential. It will not be given to anyone and shall be used for this study only.

Questionnaire Details: Fill in the spaces provided and put a tick for your answer in the boxes provided)

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1 Name of school……

2. Form……

3. Do you do practical work lessons in Biology? (Please tick) Yes ( ) No ( )

4. If yes how often do you do practical work lessons in Biology?

…….

5. (a) How long are the practical lessons? (i) 40 min …… (ii) 80 min ……. (ii) Others (specify)…….

(b) Is the time sufficient enough for carrying out practical lessons? Yes ( ) No ( )

(c) If not sufficient suggest the time that you think will be sufficient to allow you to conduct practical lessons?

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(d) Give reasons for your answers in (b)

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6. How many hours are allocated to the following Biology Lesson components? (a) Practical work lessons……

(b) Teaching theoretical lessons……

7. Do you think practicals are necessary in the teaching of Biology? Yes ( ) No ( )

Explain why?

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8. Does your school have a laboratory specifically for conducting Biology practical work? Yes ( ) No ( )

(i) If not, where do you conduct practical work lessons?

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(ii) How well-stocked is your Biology laboratory?

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…… (iii) If the school does not have the Biology Laboratory, should this prevent teachers from carrying out practical work with their learners? Yes ( ) No ( )

(iv) Explain your choice

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9. Do you have sufficient materials and equipments to teach Biology practicals? Yes ( ) No (

)

(i) Are the materials and equipments for teacher's use only? Yes ( ) No ( )

(ii) Are there enough materials and equipments for each learner to carry out practical work in Biology? Yes ( ) No ( )

(iii) In your view, what should teachers do in cases where the school does not have all the necessary Equipments and apparatus to conduct Biology practicals?

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10. Do you allow learners to use the materials and equipments in practicals? Yes ( ) No ( )

(i) If yes what is the importance of allowing learners to use the equipments during practical lessons?

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(ii) If no why don't you allow them to use the equipments during practical lessons?

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11. Are learners taught to carry out practical work on their own from lower grades? Yes ( ) No ( ) Explain your answer.

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12. Do you carry out (perform) practical work before class or in advance? Yes ( ) No ( )

13. What is the importance of carrying out practical work in advance before the actual practical lesson?

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14. Do your learners have a practical lab manual? Yes ( ) No ( )

(i) If not, what do they use as a guide when they are conducting practical work in Biology?

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15. How many learners do you have in your class?

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(i) What effect does your class size have on doing practicals?

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16. Do your students write a practical laboratory report or answer post laboratory questions or both at the end of each practical lesson? Choose your response by ticking in the appropriate box. (i) Write a lab report ( ) (ii) Answer post lab report questions ( ) (iii) Do both ( )

17. How do you assess your learners at the end of the practical lesson?

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18. Are the practicals prescribed in the Biology text book relevant to the learners'

experiences and background knowledge?

(i) If no why?

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19. Which one do you enjoy most between the following? (i) Doing practical work lessons ( ) (ii) Class teaching lessons ( )

(ii) Explain the reason for your choice.

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20. Do you enjoy doing practical work with your students? Yes ( ) No ( )

(i) If yes, what do you enjoy in the practical lesson?

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(ii) If not, why don't you enjoy doing practical lessons?

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21. What should be the role of the learner during the practical lesson?

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22. How can learners benefit maximally from practical lessons in Biology?

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23. In your view how do practicals contribute to the learners understanding of Biology?

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24. In your view how do teachers benefit from doing practical lessons in Biology?

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25. Do you give your learners tests on practical work during the course of the year? Yes ( ) No ( )

26. Do you think that your learners will be ready to answer examination questions in paper 3 (alternative to practical work) at the end of the year? Yes ( ) No ( )

(i) Explain your choice in 26.

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27. How do you make sure that all learners all involved in doing the practical?

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28. How do you make sure that all learners will get the anticipated results at the end of the Biology practical lesson?
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29. In your view, who should be doing the practical work, during the Biology practical lesson? (i) Learners only ( ) (ii) The teacher only ( ) (ii) Both the teacher and the learners ( ) (iii) Others(specify) ……
30. What do you keep yourself busy with when learners are doing the practical work in the laboratory? (a) Walk from learner to learner ( ) (b) Sit in front and do your work ( ) (c) Walk from group to group of learners ( ) (d) Others (specify)
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31. In your view, do you think that teachers should know the names and the functions of all the apparatus and equipments to be used during the practical lesson? Yes ( ) No ( )
(i) Explain your choice
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32. How often do advisory teachers visit your school to determine the effectiveness of practical lessons?
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33. What type of help do you get from advisory teachers when it comes to practical work in Biology?

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34. In your view, what factors hinder teachers from carrying out practical work in Biology?

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35. Do you think you had sufficient training to teach practicals in Biology during your teacher training? Yes ( ) No ( ) (i) If not suggest what should be done in order to help those teachers that did not receive sufficient training during their tertiary education?

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36. What can the following stake holders do to encourage teachers to do practical work in Biology?

(i) School management

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(ii) Advisory teachers

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(iii) Teacher training Institutions

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(iv) Ministry of Education

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(v) Others (specify)

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37. Any other general comments you would like to make about the teaching of practical work in Biology?

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Thank you for your help