UNIVERSITY OF EDUCATION, WINNEBA

DETERMINING THE EFFECTIVENESS OF SCIENCE PRACTICAL ACTIVITIES IN SOME CONCEPTS IN INTEGRATED SCIENCE

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A DISSERTATATION IN THE DEPARTMENT OF SCIENCE EDUCATION,
FACULTY OF SCIENCE EDUCATION SUBMITTED TO THE SCHOOL OF
GRADUATE STUDIES UNIVERSITY OF EDUCATION, WINNEBA, IN
PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF
DEGREE OF MASTER OF EDUCATION, IN SCIENCE EDUCATION.

DECEMBER, 2016

DECLARATION

I, Gilbert Bawoloriko declare that **Determining the Effectiveness of Science Practical Activities in Some Concepts in Integrated Science: a Case Study** is my work, that it has not been submitted for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged as complete references.

Gilbert Bawoloriko

Signature ....Date ....

SUPERVISORS' DECLARATION

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

Name of Supervisor: Prof. K.DTaale

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

DEDICATION

I dedicate this work to my family; Susana A. Bawoloriko my wife, and my children Wemang and Welam.

ACKNOWLEDGEMENTS

I am forever grateful to the Almighty God for His abundant Grace, Favour, Mercy and Strength. I could not have completed this work without You.

I am very grateful to my supervisor, Prof. K.D Taale for his immerse support and contributions towards the successful completion of this work. I would sincerely like to express my heartfelt gratitude to you for your patience, many in-depth constructive criticisms and valuable suggestions, which have immensely contributed to the success of this work. God richly bless you, Sir.

I am also grateful to all lecturers at the Department of Science, UEW for the tuition and great thoughts they have contributed in no small measure in conducting this research. I appreciate your encouragement and concern.

Special thanks to science tutors and students of St. Bernadett's Technical Institute Navrongo for their great support in providing the needed information for this research work.

TABLE OF CONTENTS

CHAPTER ONE

INTRODUCTION

CHAPTER TWO

REVIEW OF RELATED LITERATURE

CHAPTER THREE

METHODOLOGY

CHAPTER FOUR

DATA PRESENTATION AND ANALYSIS

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

LIST OF APPENDICES

LIST OF TABLES

TABLE **PAGE**

LIST OF FIGURES

ABSTRACT

The study investigated effectiveness of science practical activities in some concepts in integrated science. The study involved two classes of form two students in St Bernadet's Technical Institute Navrongo, who were selected through purposive and convenience sampling technique. Seventy (70) students were used for the study. A group of 35 students who represented the experimental group (EG) was exposed to intensive practical work. The other group of 35 students representing the control group (CG), was conventionally taught the same content without the use of practical activities. Data was collected using both qualitative and quantitative methods through pre intervention test and post intervention test items and questionnaires. Data collected was analyzedusing z-test, t-test and descriptive statistics.. Results from post-tests show that learners from the EG outperformed those from the CG in all the research objectives. Findings from this study show that practical work improved learners' performance. The implication for teachers is that the use ofpractical work in teaching of Physical Sciences improves learners' performance and that many resources are available locally that can be used to make the curriculum vital.The study recommends the use of practical work as an instructional strategy in science lessons at the senior high school (SHS) level.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter covers the background to the study, statement of problem, purpose of the study, objectives of the study, significance of the study, research questions, limitations and delimitations of the study.

1.1 Background

The 1984 UNESCO survey on the place of science in the school curriculum included a question on the amount of time spent on practical activities ('hands-on' science, both 'wet' and 'dry laboratory activities, and not necessarily formal experiments). The survey conducted in several countries around the world reported that;

(i) The percentage of science instruction time which is spent in the laboratory apparently ranges from 0 % to 80%, and (ii) the percentage of science instruction time spent on practical activities may increase or decrease as students move from lower secondary to upper secondary level science.

Both points need further explanation. The percentages reported for the countries (Ware,1992), may represent official expectations rather than actual classroom practice; they may be averages based on a wide or narrow range of possibilities; or they may even be based on guesswork (perhaps a more meaningful assessment of the significance given to laboratory-based instruction is whether or not it is examined). An increase in time spent on laboratory work from the lower to upper secondary levels reflects a perception of the need to prepare students in the science stream for university science courses which focus on laboratory work. Since much science knowledge is acquired by observation, data collection and controlled experiments, students in the science stream, as future scientists, need practice in these type of activities (Ware, 1992).

Many students with varied abilities benefit from learning science through an activity-oriented approach that reduces the reliance on textbooks, lectures, knowledge of vocabulary and pencil-and-paper tests (Mastropieri& Scruggs, 1994). This kind of approach seeks to promote learning by providing students with experiences that allow them to discover and experiment with science. Through discovery and inquiry, teachers involve students in creating and expanding their knowledge and understanding about the content area being studied (Mastropieri& Scruggs, 1995).

Modern science, as we all know, is the result of a creative interplay of experiments, observations and theoretical inference. A good science curriculum must not only give balanced emphasis to both theory and experiments but also integrate these two complementary aspects of science in the teaching and learning process.

There are several ways in which experiments facilitate and improve the learning of Science. First and foremost, experiments help students develop the right perspective of science, namely that science is not just a theoretical abstraction – it is an attempt to describe the working of the real world around us. A hypothesis or idea in science is acceptable only if observations and experiments confirm it. Second, experiments are among the most effective ways to generate interest in science. For many students, an apparently ‘dry’, ‘uninteresting’ fact of a theory textbook can become live and exciting when translated into an experiment. Third, experiments promote the basic skills and competencies of doing science: procedural and manipulative skills, observation skills,

skills of representing and interpreting data and the accompanying conceptual and critical abilities (American Association for the Advancement of Science,1989).

It is argued that instead of defining scientific literacy in terms of specifically prescribed learning outcomes, scientific literacy should be conceptualized broadly enough for local school districts and individual classroom teachers to pursue the goals that are most suitable for their particular situations along with the content and methodologies that are most appropriate for them and their students (DeBoer, 2000). Willey (2000) stated that, a broad and open-ended approach to scientific literacy would free teachers and students to develop a wide variety of innovative responses to the call for an increased understanding of science for all. The primary aim for the study of science in the SHS is the application of scientific knowledge to the activities of life, rather than primarily in terms of the demands of any subject as a logically organized science (NEA, 1918).

Effective power in action is the true end of education, rather than the storing up of information. The main objective of education, nowadays, is to give the learner the power of doing for himself/herself an endless variety of things which, if uneducated, he/she could not do. An education which does not produce in the learner the power of applying theory, or putting acquisitions into practice, and of personally using for productive ends his disciplined faculties, is an education which missed its main aim. (Eliot, 1898).

The challenge is to find a reasonable balance between science content and other important goals of science teaching. It is believed that the vast majority of what goes on in science classrooms today centers on conveying information about science, mainly through the use of textbooks. There is a common perception on the part of teachers that they have to ``cover" a certain amount of content. Pressure from standards, benchmarks, and high-stakes testing will only perpetuate that attitude.

For this reason, efforts at scientific literacy will be much more successful if we remove the burden of requiring all students to achieve mastery of a specific body of content. Then science teachers can feel free to experiment with alternative goals and approaches that might be more interesting and appropriate for them and their students.

Osin (1998), among others, has pointed out that we all learn best by "doing" and thus schools should devote much more of a student's time to project activities related to real-world issues, including environmental issues. Acquisition of appropriate scientific and technological skills is necessary to cope with the challenge presented by the evolving needs of modern work place in our industries and the ever growing non-formal sector.It is against this background that science education has been accorded a prime position worldwide. Science teaching is supposed to be result oriented and students centred, and this can only be achieved when students are willing and the teachers are favourably disposed, using the appropriate methods and resources in teaching the students. Students by nature are curious; they need to be actively involved in the learning process in which they are continuously equipping, testing, speculating and building their own personal construct and knowledge (Edomwonyi-Otu&Avaa, 2011). It is only by personalizing such knowledge that it becomes valid, meaningful and useful to them. In science, students need to actively construct their own personal awareness and meaning. To substantiate the argument, Usman (2000) remarked that the brain is not a passive consumer of information and to learn with understanding, a learner must actively construct meaning of what to be learned.

Despite the prime position science occupies in our educational system and the efforts made by researchers to enhance performance, students' performance in the sciences in general are still low. Some of the reasons identified for this failure according to Edomwonyi-Oto and Avaa (2011) are laboratory inadequacy, teachers' attitude, examination malpractices, time constraint, non-coverage of syllabus, class size, non-professionalism and environment.

Science practical work in schools is aimed at giving the students the opportunity to gain meaningful learning, acquire appropriate skills and attitudes that enable them live and contribute to the development of society.Literature is awash with the observation that practical work produces good performance in science (Kerr, 1963;Muwanga-Zake, 2008; Watts, 2013). Despite such observations, Kahle (1999) notes that "Schools are only as good as their teachers, regardless of how high their standards, how up-to-date their technology, or how innovative their programs". Similarly, low level content, lack of practical skills and negative attitudes towards innovative science teaching are the problems besetting teachers and consequently teachers do not use practical work in their science classes (Onwu&Stoffels, 2005; Lubben, Sadeck, Scholtz&Braund, 2010; Kibirige&Tsomago, 2013).This study therefore seeks to determine the effectiveness of science practical activities in enhancing the understanding of some science concepts.

Problem Statement

Laboratory instruction is a useful component of science learning. Given the understanding that quality science and technology education are integral to economic competitiveness and success in the global marketplace, it is not enough to teach science in a way that is based on students grasping knowledge in abstraction

Despite the effectiveness of practical work, teachers in some schools are not confident to teach science using practical work (Kibirige&Tsamago, 2013). Consequently, such teachers rely on traditional ways of teaching: lecturing, chalk-and-talk and dictation. This assession is a true reflection of what goes on at St. Bernadett's Technical Institute. These traditional strategies seem to be favoured because either there are no laboratories for learners to perform practical work (Kibirige&Tsamago, 2013) or it is because teachers lack skills, even if schools have laboratories (Muwanga-Zake, 2008). Worse still, teachers who use practical work normally depend on textbooks and teach experiments like cookbook recipes. Such teaching strategies often fail to inculcate conceptual understanding in learners. Therefore, this study aimed at determining how effective practical work in science cans enhance learners' understanding of some science concepts.

1.3 Purpose of the study

This study sought to explore and discuss ways through which environmentally friendly science practical work can enhance learner's understanding of some science concepts in integrated science. It also sought among other things to expose learners to a number of relevant activities in science that will sustain learner's interest and thus enhance understanding.

1.4 Objectives of the study

The following objectives were enunciated for the study

1. To assess the impact of regular practical activity in improving learners' performance of selected science topics.

2. To determine the impact of regular practical activity in promoting and sustaining learners' interest in science.
3. To determine whether local materials available in the area of study affect teaching and learning of some science topics

1.5 Research questions

The following research questions guided the study;

1. To what extent will regular practical activity in science promote and sustain the interest of learners in science?
2. To what extent will practical activity in science improve performancein selected topics in science?
3. What locally available materials in the area of study affect teaching and learning of some science topics?

1.7 Significance of the study

The study will seek to improve and sustain the upward improvement of students' performance in the study of science. Teachers will have the opportunity to choose from diverse and suitable means to assist the students develop their ultimate interest in learning science.

It will also enable students to make effective use of equipment and materials to improve upon their performance in science education.

Students will also appreciate the benefits that can be derived from practical activities in science in general, to enable them take career opportunities in practical related fields.

1.8 Delimitations

This study was limited to St. Bernadett's Technical Institute second year students in the Balobia Community, Navrongo of the Upper East Region becausethe researcher happens to be a teacher in the school. The research could not be extended beyond the confines of the school and for consideration of suitable sample only form two classes was used for the study.

1.9 Limitations of the Study

A more acceptable conclusion could be reached if all science lessons were treated with the practical approach, however limited time and other constraints will limit this research to few concepts in science.

2.0 Organization of the study

This study is organized into five (5) chapters with sub-headings in a systematic order. The first chapter explains the scope of the problem; it has aspects like background to the study, statement of the problem, research questions, limitations and delimitations.

Chapter two (2) is the literature review which requires the researcher to sort ideas from other related materials to the study. Chapter three (3) is on methodology which deals with how the study will be carried out and the instruments used during the intervention.

Chapter four (4) involves the results of findings. It deals with presentation and drawing comments about the study. The last chapter being chapter five (5) is summary, conclusions and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter discusses the available literature related to this study.

Practical work is a prominent and distinctive feature of science education. Many science teachers and others see practical work carried out by the students themselves as an essential element of good science teaching. As one teacher put it in an interview study, ‘it’s what science is all about really…Science is a practical subject’ (Donnelly, 1995). Some science educators have questioned the contribution of practical work to learning. Osborne (1998) argues that practical work ‘only has a strictly limited role to play in learning science and that much of it is of little educational value’. Similarly, Hodson (1991) claims that: ‘as practiced in many countries, it is ill-conceived, confused and unproductive’. Perhaps a key phrase here is ‘as practiced’. Practical investigation is central to scientific activity of all kinds. What distinguishes a scientific activity from other forms of enquiry is not the sophistication of the ideas used but the process through which these ideas are developed. A scientific approach is a process of making observations, hypothesizing, predicting and carrying out investigations, planning fair tests and analyzing the results of tests and investigations (Bradley McGurk Partnership, 1999). In doing practical work,(Millar & Abrahams, 2008) suggested that it develops learners' understanding of ideas, theories and models. Research has established that achievement and skills improved when students are taught science using practical work (Turpin & Cage,2004; Aladejana&Aderibigbe, 2007; Watts, 2013). However, as observed, (Onwu&Stoffels, 2005; Ramnarain, 2014), practical work is not done in some schools across many countries due to inadequate resources, lack of practical science skills and large classes in science. Again, teachers' attitudes towards practical work is poor, consequently they do it to satisfy the minimum requirements of the syllabus (Kibirige&Teffo, 2014).

Some authors in science education contend that practical work in science has many purposes (Woodley, 2009; Hodson, 1990; Vilaythong, 2011). For instance Watts (2013) lists some of these purposes required by the General Certificate of Education as:

"motivation for students –the excitement of discovery, consolidation of theory, development of manipulative skills, knowledge of standard techniques, general understanding of data handling, development of other skills (e.g. analytic, evaluative, planning, applied, mathematical) and understanding of how science works: concepts of scientific process, collaborative working, reproducible results, fair testing."

Another purpose for practical work is the understanding of errors and how to design practical procedures in order to improve precision and accuracy. Students acquire skills for safety; risk and precaution against hazards in the laboratory (SCORE, 2008). Practical work also provides learners with evidence to support their understanding and to concretize scientific principles (Jormanainen, 2006). Thus, learners are exposed to basic processes of science through practical work.

2.1 Does Practical Work Lead to Learning?

Tiberghien (1999) has pointed out that handling equipment and making measurements did not seem to "lead the students to establish relations between the objects and events, measurements and science concepts”. These activities are often needed in order to do practical work, but independently they do not lead to learning. Abrahams (2011) also raises similar views on the use of class time as an issue. Abrahams (2011) argues that most of class time, that of the teacher’s as well as of the students’, is used for dealing with the practicalities of the tasks, that is; giving instructions, collecting the equipment, handling them in producing the data and cleaning up afterwards. Very little or no time at all is devoted to discussing the ideas behind the phenomena or otherwise developing the conceptual skills of the students.

The decrease in practical work from lower to upper secondary level science is based on a completely different argument. It is explained that the older students 'don't need' laboratory experiences in order to understand abstract concepts. The logic continues that while primary level students need concrete experiences for effective learning in science, only lower ability older students may need such experiences (Haddad, 1986). Contrary to this view, (UNESCO, 1977) noted that traditional laboratory facilities are not needed at the primary level, but are desirable at least at the upper secondary level. These opposing views present many possible reasons for further research. However, the reality on the ground is that most experiments are sterile, un-illuminating exercises whose purpose is often lost on the learners (Hodson, 1991). In many countries, practical work is ill conceived, confused and unproductive (Hodson, 1991).

Whatever goes on in the laboratory has little to do with actual students’ learning science. Demonstrations are usually done by the teachers who also often miss the point of the demonstration. Small group work is done, but the follow up discussions on the purpose of the exercise are usually counterproductive. There is usually limited planning and formulation of hypotheses, mostly done by the teachers. In many cases according to Hodson (1991), the experiments are derived from mostly irrelevant cultural settings with the attendant equipment disasters. The students follow a fixed program of experimental manipulations and observations set by the teacher, cookbook style (Amadalo, Ocholla&Memba, 2012**).** Though research acknowledges that well planned and delivered practical work in science can play a role in influencing students' learning of science, it has to form a central part of classroom learning. Deliberate effort have to be made to attract and retain the students into the class by appealing to the curiosity raising element and discovery component of practical work in the subject. Meaningful practical work is always embedded in a discussion of ideas that makes it necessary to check observations and findings against experience and theory (Amadalo, Ocholla&Memba, 2012**).** As pointed by (Ware, 1992), the theoretical content and pedagogical content knowledge of the teacher, the ways in which the teacher delivers instruction, and the teacher's attitudes toward science have been shown to have an impact on student learning and achievement. This is especially so in the laboratory where the essence of the practical instruction is not immediately abundantly clear to the learners. Whereas the researcher appreciates the logical arguments made on this subject matter, this study also seeks to answer the the question of whether effective practical activities could develop interest in learning science amongst form two students.

2.2 Nature of discussion before and after the practical activity

Many science educators have argued (Millar, 2009), that most of the learning that results from a practical activity arises from the discussion that follows it. Meaningful practical work is always embedded in a discussion of ideas that makes it necessary to check observations and findings against experience and theory (Amadalo, Ocholla&Memba, 2012). This is particularly so if the activity aims to develop students' understanding of a scientific idea, or concept, or explanation, or model, or theory. So the nature of the discussion before and after the practical activity is important. Renner, Abraham, and Birnie (1985a, 1985b) examined ways of making the laboratory an active learning environment for students and found that discussion was pivotal. The importance of this finding is in ways enhanced by the observation that a large number of science teachers struggle with discussion as a pivotal concept in laboratory work. Similarly, Watts &Ebutt (1988) found that many students preferred laboratory work which offered them opportunities to better direct their enquiries; clearly, discussion is important in helping students to clarify their thinking and this is especially so in self-directed enquiry.

A research study, (Abrahams& Millar, 2008) found that most of the talk before practical activities was about the equipment and procedures to be used, and very little (often none) was about the ideas needed to make sense of the activity or interpret the data.

The same study also found that there was almost no discussion, during or after practical activities, about the investigation design, the quality of the data collected, or the confidence that might be in the conclusions drawn – even where there were clear opportunities to draw out and explore ideas about scientific enquiry. Results from a study conducted (Rose, 2004) showed that, strategy incorporating discussion manage to inculcate most type of science process skills. Discussions were found to be able to inculcate five basic skills and four integrated science process skills. Similarly, Gunstone and Champagne (1990) argued that laboratory work could successfully be used to promote conceptual change if small qualitative laboratory tasks are used. Such tasks aid in students' reconstructing their thinking as less time is spent on interacting with apparatus, instructions, and recipes, and more time spent on discussion and reflection.

2.3 Effectiveness of Practical Work as a Teaching and Learning Strategy

In many countries, one of the features of science education that sets it apart from most other school subjects according to Abraham and Millar (2008), is that, it involves practical activities in which the students manipulate and observe real objects and materials. In countries with a tradition of practical work in school science (such as the UK), practical work is often seen by teachers and others (particularly scientists) as central to the appeal and effectiveness of science education. Using laboratory work as a teaching strategy has many rationales according to Jokiranta (2014). They are usually categorized in 3-6 aims. These categorizations are done in almost all articles that concern practical work:

i. To help students develop their knowledge of the world and their understanding of some of the main ideas, theories and models that science uses to explain it.

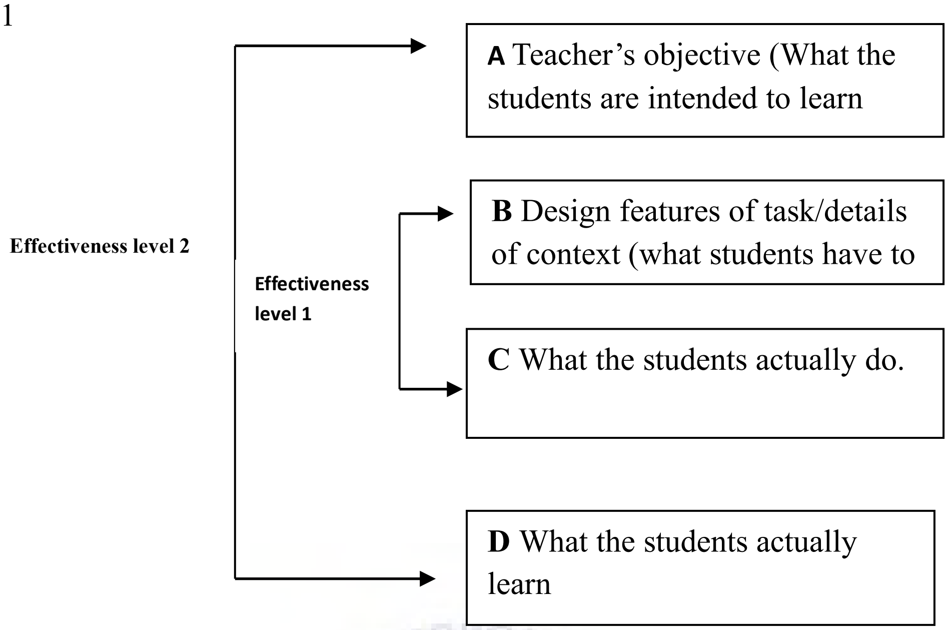
ii. To help students learn how to use some piece(s) of scientific apparatus and/or to follow some standard scientific procedure(s).

iii. To develop students' understanding of the scientific approach to enquiry (e.g. of how to design an investigation, assess and evaluate the data, process the data to draw conclusions, evaluate the confidence with which these can be asserted.

The House of Commons Science and Technology Committee (2002a), for example, commented that, practical work, including fieldwork, is a vital part of science education. It helps students to develop their understanding of science, appreciate that science is based on evidence and acquire hands-on skills that are essential if students are to progress in science. Students should be given the opportunity to do exciting and varied experimental and investigative work.

Practical work, as several authors have pointed out, is a broad category that encompasses activities of a wide range of types and with widely differing aims and objectives (Lunetta&Tamir, 1979; Millar, Le Maréchall&Tiberghien, 1999). To Abraham and Millar (2008), it does not make sense, therefore, to ask whether practical work in generalize an effective teaching and learning strategy. Rather, we need to consider the effectiveness of specific examples of practical work, or specific practical tasks. To think about what we mean by the 'effectiveness' of a teaching/learning activity, it is useful to consider the stages involved in developing and evaluating such an activity (Millar, 2009).

Fig 1



The process of developing and implementing a practical task. (from Millar, Tiberghien&LeMarechall, 2002).

The starting point (Box A) is the teacher's learning objectives - what he or she wants the students to learn. This might be a specific piece of substantive scientific knowledge or a specific aspect of the process of scientific enquiry (about, for example, the collection, analysis, or interpretation of empirical evidence). Once this has been decided, the next step (Box B) is to design (or select) a practical task that might enable the students to achieve the desired learning objectives. The next stage of the model (Box C) asks what the students actually do as they undertake the task. For various reasons, this may differ to a greater or lesser extent from what was intended by the teacher (or the author of the practical task). For example, the students might not understand the instructions; or they may understand and follow them meticulously but be prevented by faulty or inadequate apparatus from doing or seeing what the teacher intended. Even if the task is carried out as intended, and the apparatus functions as it is designed to do, the students may still not think about the task and the observations they make using the ideas that the teacher intended (and perhaps indeed expected) them to use. We can think of this as a matter of whether or not students do the things the teacher intended with *ideas*; that is, their mental actions as distinct from their physical actions. The final stage of the model (Box D) is then concerned with what the students learn as a consequence of undertaking the task. This model therefore distinguishes two senses of ‘effectiveness’. We can consider the match between what the teacher intended students to do and what they actually do (the effectiveness of the task at Level 1); and the match between what the teacher intended the students to learn and what they actually learn (the effectiveness of the task at Level 2). ‘Level 1 effectiveness’ is therefore concerned with the relationship between Boxes B and C in Figure 1, while ‘Level 2 effectiveness’ is concerned with the relationship between Boxes A and D. In the discussion above, we have already alluded to a further dimension—the kind of action (physical or mental), and hence learning, involved. The fundamental purpose of practical work in school science is to help students make links between the real world of objects, materials and events, and the abstract world of thought and ideas (Tiberghien, 2000).

Practical activities that strongly involve the domain of ideas have a significantly higher learning demand than those which simply aim to allow students to see and remember an observable event (Leach & Scott, 1995). In such activities, students are likely to require assistance to use or develop the ideas that make sense of the activity, and lead to learning. Millar (2009) holds that activities that have this kind of ‘scaffolding’ built into their design are likely to be more effective than ones which do not.

Driver (1983) suggested that instead of learners dealing with already known answers, such as determining known constants, they need to investigate novel problems. In this way practical work supports development of scientific skills, thinking skills and how scientists work.

However, other researchers found that the inquiry approach in practical work requires much time and a session of one hour is never enough (Abraham & Millar, 2008). Practical work caters for learning in different ways such as experiential, independent, team and peer dialogue (Zimbardi, Bugarcic, Colthorpe, Good &Lluka, 2013). Different learning styles have the pedagogic benefit of enabling correct concept development. They underscore the empirical nature of science, measurement, repeatability of experiment and learners may enquire as real scientists do. Contrary, Hodson (1990) argues that the only field where practical work seems to be a good method is laboratory skills: the “area the other methods did not attempt to teach”. Practical work may be considered as engaging the learner in observing or manipulating real or virtual objects and materials (Millar, 2004).The argument continuous that appropriate practical work as (Amadalo, Ocholla&Memba, 2012) pointed out in their study, enhances pupils’ experience, understanding, skills and enjoyment of science. The same study concluded that Practical work enables the students to think and act in a scientific manner. The scientific method is thus emphasized. Practical work induces scientific attitudes, develops problem solving skills and improves conceptual understanding (Tamir, 1991).Practical work in science helps develop familiarity with apparatus, instruments and equipment. Manipulative skills are acquired by the learners. Expertise is developed for reading all manner of scales. The observations made and results obtained are used to gain understanding of science concepts (Tamir, 1991. Science process skills, necessary for the world of work are systematically developed (Manjit, Ramesh & Selvanathan2003). Firsthand knowledge is generated. Abstract ideas can be concretized. Naïve, neonate and scientifically primitive ideas can be challenged (Osborne, 2002).Tacit knowledge of scientific phenomena can be gained (Collins, 2001). Practical work creates motivation and interest for learning science. Students tend to learn better in activity based courses where they can manipulate equipment and apparatus to gain insight in the content. To Millar (1998), practical work should be viewed as the mechanism by which materials and equipment are carefully and critically brought together to persuade the science learner about the veracity and validity of the scientific world view.

2.4 Encouraging Students Participation in Lessons

Recently, there has been much emphasis on participatory classroom activities because there is a general agreement that, effective learning requires students to be active in the learning process. Parkinson (2004) and Bligh (1998) argued that focusing students' attention on the material to be learned is an important factor in effective learning. The use of visual teaching aids can provide more concrete meaning to words, show connections and relationships among ideas explicitly, provide a useful channel of communication and strong verbal messages and memorable images in students' minds, and make lesson materials more interesting to students (Duit, 1991; Cyrs, 1997; Harlen, 1999; Joyce,Weil&Calhain 2000a). In addition, researchers believe that the more students are involved in the learning process, the more they learn the topic (Trowbridge, Bybee& Powell 2000; Deboer, 2002). Taras (2002) suggests that student-centered learning has, in theory, promoted and brought about greater student participation and involvement.

Saunders (1992) argued that Meaning can only be formed in students' minds by their own active efforts and cannot be created by someone else for the students. This according to Cimer (2007) suggests that students are not simply passive recipients of information from the teacher, computer, textbook or any source of information during the learning process. They have to wrestle with an idea in their own minds until it becomes meaningful to them.

Joyce *et al* (2000a) state that the opportunity to exchange views and share personal experiences produces the 'cognitive conflict' that is fundamental to intellectual development. In order to foster cognitive conflict, students need opportunities to pose questions about science, to work with others, to conduct investigations, present and defend their ideas, solutions, and findings, and assess their own and other students' reasoning (Pope & Gilbert, 1983; Tobin & Gallagher, 1987). Again, Cimer (2007) believes the implication of these is that, they need to participate in learning process. Active learning techniques can empower students to make good decisions and take an active role in their own learning, increase their motivation to learn, foster and value the diverse voices of students and reduce disciplinary problems (McCombs &Whisler, 1997; Stepanek, 2000; Deboer, 2002).

Many different methods and strategies have been suggested for involving students in lessons and engaging them in active learning (Trowbridge *et al*; 2000; Deboer, 2002;). Harlen (1999), however reports that in order for any method to be successful, effective lesson planning is essential. A lesson plan requires the teacher to be clear about the sequence of the activities in the lessons, the purpose and goals of the lessons. The planning process involves clarification of the roles of the teacher and the students (Cimer, 2007). Effective lesson planning according to (Glenn, 2001), has a positive effect on students' learning.

Questioning has been identified by ((Bliss, 1995; Glenn, 2001; Amos, 2002). as the most common strategy that teachers use for involving students in the learning process. Indeed, Amos (2002) reports that up to one-fifth of what a teacher says in a classroom is likely to be in the form of questions. Therefore, as Harlen, (1999) puts it, If teachers ask open-ended questions, they allow students to think freely and flexibly, to express their own ideas and thoughts without thinking that they have to give one 'right' answer and they promote successful discussions that stimulate students participation. Amos (2002) supports the use of open-ended questions, arguing that closed and subject-oriented questions that rely on linear processes and logical reasoning discourage students from thinking differently from the teacher and may deter students from answering the questions asked. This means that the process of asking questions is also important for students' learning and development. Providing sufficient 'wait time', about 3-5 seconds, after asking a question for students according to Trowbridge *et al,* (2000), not only increases student participation but also provides them with opportunity to think critically and create more ideas and responses.

Role-playing can also be a useful teaching and learning activity to encourage students to participate more in the lessons and facilitate their understanding (Cimer, 2007). McSharry and Jones (2000) point out that the theory behind the use of role-play in science teaching and learning supports 'active', 'experiential' or 'student-centred' learning. Therefore, students are encouraged to be physically and intellectually involved in their lessons to allow them to both express themselves in a scientific context and develop an understanding of difficult concepts. McSharryand Jones (2000) further argued that, role-plays, such as those describing predator–prey relationships or antibody–antigen interactions, can give students a chance to experience these events in a physical way, which may be more appropriate to their personal learning style. Fadali, Robinson, and McNichols (1999) point out that role-playing may be useful in secondary science classes as a way of introducing and familiarizing students with difficult, abstract or complex concepts in biology and the physical sciences.

Another useful method for enabling students to participate in the learning process is to conduct practical work (Hodson, 1993; Amos and Boohan, 2002; Millar, 2002). The important point in doing practical work is to ensure that students are mentally active because engaging students in practical tasks does not mean that they are active in their learning. In sum, students' participation is necessary for their learning. Active participation can increase students' learning, understanding and motivation to learn. Teachers should make sure that students are mentally active in the lessons and create opportunities for them to participate in the lessons. This study also investigated the effectiveness of practical work in promoting and sustaining students interest in science.

2.5 Available Science Practical Teaching and Learning Materials

Practical activities at different levels of sophistication are present in the majority of school science curricula at the primary level and particularly at the lower and upper secondary levels. Practical activities usually require special facilities and equipment. Although fully equipped laboratories and sophisticated equipment are by many considered essential, it is not necessarily so (Musar, 1993). It has been argued that traditional laboratory facilities are not needed at the primary level, but are desirable at least at the upper secondary level (UNESCO, 1977). Musar, (1993) indicates that in many countries, science education is suffering from a lack of appropriate facilities and supporting materials, including the equipment. Modern curricula and textbooks based on discovery learning are sometimes used, but in the absence of practical activities it is questionable if the students receive a better understanding of science than they did when books and curricula were based on lecturing and blackboard teacher demonstrations (Hakansson, 1983).

In an attempt to improve the situation, the World Bank has supported secondary school science in over 100 projects; generally the equipment components were a substantial part of the total expenditures (Musar, (1993). In the Bank's evaluations, almost half of the outcomes were assessed to be negative. In an internal Bank review according to el Hage, Rinaldi, Ware and Thulstrup (1992), it was found that hardware was emphasized at the expense of other components, for example teacher training. Other Bank projects, which were successful from the equipment acquisition and distribution point of view, were found not to improve the quality of science education substantially. In some cases the equipment provided was not used at all, and it was possible to find twenty years old equipment kits still in their original packages (Somerset, 1993; Schmidt, 1983a). There are many possible reasons for equipment supply projects to fail. Some of them are listed below.

2.5.1 Cost of equipment

Investments in equipment for all students at a given level are a heavy financial burden for a developing country. Essential follow-up procedures like teacher training in the pedagogica land technical use of the equipment, provision of maintenance, and replenishment, etc., are sometimes not accomplished because of the lack of funds (Musar, 1993); Dalgety, 1983; GTZ, 1983) point out another risk in connection with the high cost of equipment. It is sometimes safely locked up in the school and not used at all, because the teacher is afraid that he/she or the students might break it and that he/she will have to pay for it from his/her own pocket.

2.5.2 Educational unsuitability of the equipment

The equipment is not always relevant to the curriculum. In other words, it is designed for experiments that do not suit the curriculum. Envisaged changes in the curriculum are sometimes not taken into account in connection with equipment purchase, even if they are supposed to happen in the near future. On the other hand, in practical implementations of the curriculum there is sometimes little or no time allotted for practical work. Another possibility is that the educational value of the experiments is low because they fail to demonstrate scientific concepts convincingly, or do not illustrate the connection between scientific principles and the real world. The reasons might be use of unfamiliar materials, practical work following 'cookbook recipes' without real understanding of the process, or use of 'black boxes' - unexplained and unfamiliar equipment where input and output do not have any apparent connection.

2.5.3 Teacher training

In pre-service training, future teachers often get work experience with equipment they are not likely to use after graduation. They are not trained to work with the kind of equipment which is actually in use in schools, or to work with little or no equipment at all. They are seldom taught how to use and improvise with local materials. Maintenance and repair of the equipment are rarely included in pre-service teacher training. The future teachers do not develop managerial skills in selecting and acquiring equipment and consumable materials, although they in some countries are responsible for that, using the school budget.

2.5.4 Incentives

Teachers are often not motivated to put additional effort into the preparation of practical work (demonstrations and experiments). The social status of science teachers in many developing countries is low, as well as their salary. They are frequently forced to take second jobs.

2.6 Locally Available Materials for Teaching-Learning Science

Having the right resources available at the appropriate time is an obvious pre-requisite for high quality practical work (SCORE, 2008). Teachers are continually being urged to use resources at hand to make our curriculum more vital and meaningful to girls and boys (UNESCO, 1956). Very often subject matter and methods of instruction make things near at hand seem foreign and far away, because teaches try to teach without relating them to the children’s experiences. (UNESCO, 1956) reports that a list of all the possible resources in a rural area would be endless and no two regions would contain the same possibilities.

Learning science as Yitbarek (2012) points out, should start with hands on experiences that the child is familiar with and not with abstract definitions about what science is. Low cost apparatus from locally available materials is believed to enrich the capacity to observe, explain and do real science in primary schools and increases the quality of learning (Yitbarek, 2012). Currently there is an urgent need everywhere in the world to have low-cost instruments and low-cost experiments for teaching science. The situation is particularly serious in developing countries. As Tilahun, Sileshi and Anteneh (2011) indicated, in spite of various efforts, shortage of school laboratory apparatus continues to be a major problem which should be of serious future concern. There should be a gradual shift from importing expensive apparatus to a reliance on low cost apparatus designed and manufactures by utilizing locally available resources. Yitbarek (2012) noted that we are all born with the ability to be investigators; however, we have to learn how to do it. Hence if we base our teaching of science with locally available, it will make learning by doing accessible, even when the conditions for teaching are not conducive. It is believed that, using locally available materials, most school experimental lessons can be performed in a very short time, often with no or low financial input and without long sessions of preparation. According to many scholars the advantage of using low cost materials (Yitbarek, 2012) can be summarized as;

- Use of local materials makes teachers and learners aware of the resources to be found in their environment and stimulates creativity to use them.

- The experiments and models can be constructed in a very short time, with a few tools, with locally available materials even by unskilled persons as part of pre- and in-service teacher training.

- The self-construction develops a sense of proud ownership and promotes a more frequent use.

- Repair and replacement of broken parts are possible locally without technical or administrative problems.

- For the storage no special storage facility is needed; a lockable cupboard is enough. Security is no problem, because of the low material value.

- For the implementation no special infrastructure is needed. The innovations go straight to the schools. What has been learned today in a training workshop can be applied tomorrow in the classroom (Yitbarek, 2012).

2.7 Designing an Experiment from Locally Available Materials.

A frequent criticism of practical work in school science is over-reliance on 'cookbook' or 'recipe following' tasks – where students are given detailed instructions on what to do, often in the form of a worksheet. Students, when doing such activities, often lose sight of the overall purpose and follow the instructions rather mechanically and without much thought (Millar, 2009).

In designing and producing appropriate locally available materials in teaching-learning science, Yitbarek (2012) outlined the following steps:

- Making a careful study of the conventional apparatus or experiment.

- Thinking of some low cost substitute that may be available in the locality.
- Designing the improvised apparatus or experiment.
- Putting the improvised apparatus or experiment to test. Making further improvements in the improvised apparatus keeping the test results in mind.
- Making use of the improvised apparatus in the laboratory for demonstration or practical work.

In spite of the many efforts to make science education effective and popular, there are many problems faced by planners and people responsible for the development of science education and among these problems the major once are related to practical activities (Iffat, 1994).

2.8 Evaluation of Students Performance

Assessment for Learning has been defined as the process of seeking and interpreting evidence for use by learners and their teachers to decide where learners are in their learning, where they need to go and how best to get there (Assessment Reform Group, 2008).

Effective teaching requires teachers to check continuously the development of students' understanding and give detailed positive feedback in order to make sure that students correctly integrate new knowledge into the existing knowledge structure (Svinicki, 1999; Cimer 2004). In addition, in order to identify and correct students' mistakes at an early stage before they become too deeply embedded, teachers need to continuously monitor and evaluate students' understanding (Hipkins*et al*, 2002). Performance and student-centered assessments seek to connect assessment and instruction and involve students in examining the process and products of learning(Salend, 1989). In performance assessment, students reveal their skills, problem-solving abilities, and knowledge and understanding of science by creating and making things, developing projects, solving problems, producing written products, responding to simulations, giving presentations, conducting investigations, and designing and performing experiments.

Students can be involved in the assessment process through use of such student-centered assessment strategies as portfolios (Rueda & Garcia, 1997), journals and learning logs (Davison & Pearce, 1992), think-alouds (Andrews & Mason, 1991), and self-evaluation questionnaires and interviews (Pike &Salend, 1995). These assessment strategies provide students with opportunities to monitor their progress, evaluate their understanding, and gain insights into the ways they approach and think about science.

Portfolios are archival in nature and consist of student products selected by both students and teachers over a period of time. Portfolios are continuously examined by students, educators, and families to reflect upon and document the students' growth, effort, attitudes, and the processes they use to learn science. Journals and learning logs offer students opportunities to react to and reflect upon their learning and to develop their skill at communicating scientifically (Davison & Pearce, 1992). Think-aloud techniques involve teachers prompting students to verbalize the processes they are using and their thoughts while working on a science activity by asking students to respond to a variety of questions (e.g., As you work on that activity, what are you thinking about? How did you arrive at that solution?(Salend, 1989). Similarly, self-evaluation interviews and questionnaires are designed so that students respond to a variety of questions that reveal their approach to various learning activities, their perceptions of their educational needs, and their progress in understanding science. Information collected from these student-centered assessment strategies can be used to devise instructional strategies that help students become better learners.

The process of evaluating students' work or performance and using the information obtained from these practices to modify teachers' and students' work in order to make teaching and learning more effective is known as formative assessment (Gipps, 1994; Black, 1995; Black &Wiliam, 1998). Research has shown that it has great potential for improving the quality of teaching and learning Black and Wiliam (1998); Black and William(1998) also indicated that if assessment occurs early in the teaching-learning sequence, it can reveal information about students, which can be used to guide the planning of teaching so that it takes account of students' existing conceptions. Furthermore, the emphasis of formative assessment on providing students with continuous feedback on their performance aims to engage students in self-assessment of their learning, and hence, it can be argued that formative assessment can increase student participation in the learning process (Black, 1993; Black &Wiliam, 1998; Cimer, 2004).

Students engaging in self-assessment have more control over their learning and use the feedback to modify their learning behaviors (Goodrum, Hadding&Rennie 2001). The effectiveness of formative assessment is strongly related to the quality of the feedback given to students (Crooks, 1988; Black &Wiliam, 1998) and action taken by students based on the feedback (Sadler, 1989).

Cross (1996, p4) provides a vivid and evocative metaphor for learning without feedback where it is likened to learning archery in a darkened room. Mistakes, rather than simply telling them what they have done wrong or the pieces they are missing (Stepanek, 2000; Tytler, 2002b). Correcting students' mistakes by telling them the right answer does not make for effective strategies. 'Judgments' and 'being wrong' might cause students not to reveal and discuss their ideas in the classroom (Cimer,2004). Besides, such a practice encourages passive learning and teacher-dependency. Brookhart (1997) further explained that the feedback should provide students with adequate information about their performances and should guide students about what to do next to improve. For example, simply saying 'excellent', 'not as good as it could be', 'you must do better next time', and 'unsatisfactory' or 'try harder' might not be helpful for students to improve themselves.

The quality of teacher questions is also important. In checking students' understanding according to She and Fisher (2002), teachers should ask open-ended questions that allow students to express their own understanding and conceptions, and put less emphasis on recalling facts that reduce opportunities for students to be creative and critical in their thinking. Amos (2002) argues that such questions require students to apply, analyze, synthesize, and evaluate information, which were considered as 'high order thinking skills' in Bloom's Taxonomy of Educational Objectives (Bloom, 1956). In addition, She and Fisher (2002) suggest that questions should help students interpret their observations, link new learning to what students already know, and stimulate their thinking. Instead asking test-based questions which might target students' higher order thinking skills, Pallrand (1996), reports that the essential way to assess how students organize information is to ask them to provide explanations of the processes. Indeed, Osborne (1997) argues that it is only when students are required to explain a concept to somebody else that they really start to understand it. The logic remains that Continuous assessment and providing detailed performance feedback is necessary for students to improve their understanding and learning.

2.9 Students Attitudes to Practical Work in Science.

One of the goals of science teaching is to encourage students to have positive attitude towards science for positive effects on students learning (Northwest Region Education Laboratory (NREL, 2002).

An attitude involves the communication of an evaluative judgment about a stimulating object, where the evaluation is the essential aspect of the attitude concept (Maio& Haddock, 2010; Olson & Kendrick, 2008; White, 1988). Within science education, Gardner (1975) has often been referred to as providing clarity over terms relating to attitudes towards science. Gardner (1975) explained how an attitude always consists of a specific ‘attitude object’ which stimulates the subjective response. It has been largely agreed that an attitude is held intrinsically within the individual, and thus, is inaccessible to direct observation. However, it is observable on the basis of a measurable response to an attitude stimulus (Ajzen, 2005). Related to attitudes, are opinions. According to Kim and Song (2009), an opinion is a verbal expression of an attitude. Yet research has still identified an ‘attitude towards science’, as an attitudinal construct. However, Koballa and Glynn (2007) define attitudes as a general expression of either positive or negative feelings towards something and this distinguishes it from other terms like value, belief or opinion. The importance of researching students' attitudes towards science has been highlighted by the Organization for Economic Co-operation and Development (OECD, 2010) who believe that a student's 'scientific literacy' should include certain attitudes, beliefs which by possessing and utilizing effectively, it is believed this will benefit the individual, the society and worldwide.

Among educators and researchers alike, it is commonly assumed that students' attitudes in science influence their learning outcomes, their science course selections, and their future career choice (Fortus, 2013). Thus, Nieswandt (2005) holds the view that changing attitudes should lead to changing behaviour. Practical work is seen as having an important role in school science. Sharpe (2012) reports that practical work has an essential role in determining students' attitudes to school science and science beyond the classroom. However, whilst there has been much research into students' attitudes to science there has been little research into their attitudes to practical work in particular(Sharpe, 2012). Research has suggested the need to understand why students think the way they do to better understand and hopefully benefit student uptake as well as enhancing student engagement and enjoyment in science (Barmby, Kind & Jones,2008). As is currently practiced, students claim to find practical work an 'enjoyable and effective way of learning science' (Hodson, 1992, p.115) and this has been reported in many previous studies (Osborne & Collins, 2001; Jenkins & Nelson, 2005). As Abrahams& Millar (2008) indicated, many teachers view practical work "as central to the appeal and effectiveness of science education". Indeed, reference is often made to the adage, 'I hear and I forget, I see and I remember, I do and I understand' written originally by Confucius. There have since been many similar comments in literature, noticing some links between the use of practical work and students' engagement/enjoyment of science (SCORE, 2008). Also, researchers have often discussed the potential links between positive student attitude and its influence on continued participation and attainment(Chen & Howard, 2010; Kim & Song, 2009). It could be understood that positive attitudes towards science may mean students are more inclined to participate and/or be more motivated to achieve. The study by Rennie (1994) found that students visiting science education centres did benefit and enjoy the experience and that through instruction linked to the visit (rather than how long ago the visit occurred) was more influential to their enjoyment. Similar findings on students' affective attitude were commented on by Abrahams (2009) where students enjoyed conducting practical work but it is argued that this is because they preferred it to other learning activities, just as they would a visit to a science education centre. Practical work and science educational visits can SCORE (2008) create enjoyment and/or have a positive impact on students' learning of science as seen through some research. Chen and Howard (2010) however suggests the need for continued re-stimulation because the engagement and enjoyment created is more likely to be short-term. Moreover, there needs to be support with science content for this to influence the affective domain as a long-term feature in a student (Rennie, 1994).

Thompson and Soyibo (2002) reported in studies that practical work was important means for enhancing attitudes, stimulating interest and enjoyment, and motivating students to learn science. Hofstein and Lunetta (2004) made similar argument that hands-on activities have the potential to enhance positive attitudes and cognitive growth. However, as highlighted by Abrahams (2009), the majority of studies that have expressed such positive perspectives of practical work, have focused more on the rhetoric through questionnaires on students views, than the actual reality of practice and behaviour of students. In a similar view, White (1988) assumes the stance that an attitude relating to science must be the amalgamation of the individuals' beliefs, behaviour and emotions relating to the stimuli and therefore, as Bagozzi and Burnkrant (1979) reported, an attitude is the interplay of the affective, cognitive and behaviour domains. Baker (1998) found that students having a negative attitude towards science may have more to do with the student not finding themselves suiting the image of science and as Jenkins and Nelson, (2005) pointed out, this is referred as lacking cognition in science. Certainly, there is an underlying theme running through the arguments on attitudes to practical work, that there is a need for greater and deeper exploration into students' attitudes to practical work, separate to their attitudes to science.

2.10 Knowledge of Teaching and Learning Strategies

Studies have found a somewhat stronger and more consistently positive influence of education coursework on teachers' effectiveness. Ashton and Crocker (1987) found significant positive relationship between education coursework and teacher performance in four of seven studies they reviewed -a large share than those showing subject matter relationships.

Evertson, Hawley and Zlotnik (1985) reported a consistent positive effect of teachers' formal education training and students' learning. Monk's (1994) study of students' mathematics and science achievement found that teacher education coursework had a positive effect on students' learning and was sometimes more influential than additional subject matter preparation. Teachers' coursework credits in chemistry were not significantly related to their students' achievement on tasks requiring problem solving and applications of science knowledge (Perkes, 1967). Teachers with greater training in chemistry teaching were more likely to use laboratory techniques and discussion and to emphasize conceptual applications of ideas, while those with less or no education training placed more emphasis on memorization.

A program-based, study by Denton and Lacina (1984) found positive -relationships between the existence of teachers' professional education course work and their teaching performance, including their students' achievement. Guyton and Farokhi (1987) found consistent strong and positive relationships between teacher education coursework performance and teacher performance in the classroom as measured through a standardized observation instrument. Additionally, the relationship between classroom performance and subject matter test scores were positive but insignificant while relationships between classroom performance and basic skill scores were almost non-existent. Mental images, combining objects and ideas in new ways; offering explanations for objects and events encountered, questioning, producing alternate or visual uses of objects, solving problems and puzzles, designing devices and machines, producing ideas and devising tests for explanations. The development of the above domain will not be achieved if practical work is not effectively organized during chemistry lessons.

Domains such as values, human feelings and decision making skills are also important to be addressed at the senior high school level. Practical work done in groups, enables students develop, positive attitudes towards themselves, positive attitudes towards science in general and science teachers. The students also develop sensitivity and respect for others while expressing personal feelings in a constructive manner, making decisions about personal values as well as social and environmental issues.

Practical work done by students during science lessons aid students to acquire knowledge of scientific concepts in everyday life. It also enables them to apply the learned concepts and skills to everyday social problems, understanding scientific and technological principles involved in household technological devices, and the evaluation of mass media reports of scientific development. A diverse and growing body of opinion points to the need for an overhaul of Africa's public educational systems to address the needs of Africans (Brown-Acquaye, 2001).

It may be that the positive effects of subject matter knowledge are augmented or offset by knowledge of how to teach the subject to various kinds of students. That is, the degree of pedagogical skill may interact with subject matter knowledge to bolster or reduce teacher performance. As Byrne (1983) suggested, it is surely plausible to suggest that in so far as a teacher's knowledge provides the basis for his or her effectiveness, the most relevant knowledge will be that which concerns the particular topic being taught and the relevant pedagogical skills.

A pedagogical strategy for teaching must be to the particular types of students to whom it will be taught. The kind and quality of in-service professional development as well as pre-service education may make a difference in developing this knowledge. Several recent studies in mathematics (Darling-Hammond - 2000) have found that higher levels of student achievement are associated with mathematics teachers' opportunities to participate in sustained professional development grounded in content - specific pedagogy linked to the new curriculum they are learning to teach. In these studies, 'both the, kind and extent of professional development mattered for teaching practice and for student achievement. Darling-Hammond (2000) also found that students achieved at high levels and were less likely to drop out when they are taught by teachers with certification in their teaching field, by those with master's degrees and by those enrolled in graduate studies. Continuity of teachers' learning may also matter that teachers in exemplary chemistry programs had higher levels of education and more recent educational experiences than others, even though they were older than the average chemistry teacher.

As Murnane (1985) suggested, these findings may indicate that it is not only the knowledge acquired with ongoing professional development but also the teacher's enthusiasm for learning that relates to increased student achievement. A profession is expected to have strong technical culture with a specialized body of knowledge gained through an extended period of advance training. Antwi (1992), in Ghana, noted, that the teaching profession is still in the process of building up a specialized and systematic education based on intellectual training. Consequently, some people with various levels of education, including those with no professional qualification have been employed as teachers. Probably some of the science teachers currently on the fields are not professionally qualified. Among all academic - based professions, it is only in teaching that non-professionals or those without the requisite professional qualification and training are allowed to teach subjects which are not of their special area (Antwi, 1992). Probably these findings apply to the teachers in this study.

CHAPTER THREE

METHODOLOGY

3.0 overview

This study sought to explore and discuss ways through which environmentally friendly science practical work can enhance learner's understanding of some science concepts in integrated science. It also sought among other things to expose learners to a number of relevant activities in science that will sustain learner's interest and thus enhance understanding.

This section of the research report deals with the methods and procedures used in collecting data for the study. It outlines and explains the procedure which were followed to gather primary data regarding the views of the tutors and students to assess the teaching and learning of science in St Bernadette's Technical Institute.

Areas discussed in the chapter included; research design, population, sample and sampling technique, data collection procedures, instruments, validity of instruments, and data analysis. It also highlights the intervention design and implementation.

3.1 Research Design

The research design used for the study was a quasi-experimental research. The quasi-experiment, also known as 'field-experiment' or 'in-situ experiment', is a type of experimental design in which the researcher has limited leverage and control over the selection of study participants. Specifically, in quasi-experiments, the researcher does not have the ability to randomly assign the participants and or ensure that the sample selected is as homogeneous as desirable. (Leedy& Ormrod,2010). Additionally, in numerous investigations, including this very study, randomization may not be feasible, leaving the researcher with pre-assigned groups.

This research was conducted to find out how effective is science practical activities in improving the performance of students in science at St. Bernadette's Technical Institute. The design was appropriate for this particular study since it employs both quantitative and qualitative techniques in gathering and analyzing a variety of data/information as well as to come out with the appropriate intervention that will provide answers to the research questions raised.

The researcher employed practical activities in teaching some concepts in science as an intervention strategy. The pretest post-test design was used alongside student's questionnaire.

3.2 Population and Sampling Procedures

Sampling involves the selection of a number of study units from a defined study population (Fraenkel&Wallen, 2000; Alhassan, 2006).

The researcher involved a total of 70 second year students from two different classes i.e, Business Accounting II (BAII) and Business Secretariat II(BSII) as the study sample. The results of these students' mid-term exams were used as pre intervention test. BAII with 35 students was purposively categorized as the experimental group and the BS II with another 30 students as the control group.

3.3 Topics Selected for the Study

For the purpose of designing instrument for this study, a thorough examination of senior High School science curriculum (SS1-3), from which the senior High School II science syllabus is drawn, was undertaken with a view to selecting topics that emphasize major areas of West African Senior School Certificate Examination (WASSCE). Three topics were selected from the major areas of the subject. These are presented in Table 1below:

Table 1.Topics selected for the study

S/N Topic	Area
1. Photosynthesis	Biology
2. Mixtures	Chemistry
3. Osmosis & Diffusion	Biology

3.4Treatment

Learners in the two groups were exposed to two instructional approaches; the practical approach and the traditional. This will continued for a period of three months making a full term of academic work. The control group was left to go through their normal routine learning with their subject teachers who did not vary their teaching approach. The experimental group was taken over by the researcher where the researcher employed the practical approach to deliver lessons for the same period.

Learners were actively involved in organizing the apparatus some of which are locally available in the school environment: yam, bottle tops, transparent plastic cups cardboards etc., preparing them and setting them up for experiments. Though the structure labeled science lab is inadequately equipped, the experimental group did visited a nearby school (Notre Dame Seminary Senior High School) for some practical activities. Learners were given the opportunity to interact intensively during the practical activities.

3.5 Data Collection Instruments

To ensure reliable results, many instruments were used to conduct the study; these included a set of pretest and post-test treatments, student's questionnaires, interviews and observations.

At the end of the three months (term) both groups were subjected to the same examination. The grades from the mid-term and end of term exam formed the post test scores used in the analysis.

Two sets of questionnaires were designed for the science tutors and the students. Both students and tutors perceived the problem at stake from different perspectives and had different roles to play in this study. Each of the two sets of questionnaires consisted of two sections respectively. Section 'A" comprised of a rating scale items, while section 'B' in the main incorporated 'multi-choice select' as well as open-ended items. The general advice was to keep questions or statements as short as possible (Dillman, (2000).The questions raised in the items remains quite clear to invoke the views of respondents in the experimental group on effectiveness of using experiments in science lesson delivery.

Observations made during the practical activities enabled the researcher personally see how both tutors and students behave in the teaching and learning of science in the classroom and at the science laboratory as well as during field practical work. This ensured that the responses to questionnaires and interviews reflect the reality on the grounds.

3.6 Validity and Reliability of Instrument

In order to make responses to the questionnaire reliable and valid, specimen questionnaires for both tutors and students were sent to the supervisor of this research for corrections and suggestions. The questionnaires as well as the content material for the selected topics were also made available to some tutors of science as well as other colleagues at the school to look through. As suggested by Kimberlin and Almut (2008), reliability estimates are used to evaluate the stability of the many items to be administered to same individuals. According to Crocker and Aligina (2008) pilot or pretesting an instrument allows for the identification of measurement errors that would be detrimental to useful score interpretation. These items were pilot tested at St. John's Integrated Senior High Technical School in Navrongo. This exposed some deficiencies in the items for corrections to avoid inconsistencies in responses among others. The pilot test was done two months before the start of the data collection period. This helped the researcher make all the necessary revision needed to establish an effective data collection tools for the study.

3.7 Data Analysis

In analyzing the responses raised by the research questions, the study employed both quantitative and qualitative methods. The graded scores from both the pre and post interventions for the two groups were analyzed using these methods to appreciate the effectiveness of practical work on learners understanding of some integrated science concepts.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Overview

This chapter presents and discusses the findings from the investigations in relation to the three research questions. The research questions are discussed using quantitative z-test and t-test statistical tools and qualitative descriptive analysis of the pre-test and post-test mean scores as well as the responses of from the student's questionnaire.

4.1 Research question one

To what extent will practical activity in science improve performance in selected topics in science?

The Pre-Test scores for the respondents were obtained from the end of form one examinations. The experimental and the control groups had mean performances of 35.44 and 38.03 respectively on the Pre-Test. These results showed that the two groups were of comparable ability. These results indicate that low performance in the selected school is already entrenched by the end of form one of secondary school education. The total scores on the weekly quizzes and end of term exams were compiled and expressed as a percentage, for every respondent in each of the experimental and control groups. These performances were the Post-Test scores. The mean performance and the standard deviations for each group were determined. The results are indicated in Table 2.

Table 2: Group performances on the pre and post test

Group	Number of respondents	Mean of performance	Standard deviation	z-test
Experimental Group Pretest	35	35.44	16.66	
Control Group Pretest	35	38.03	14.65	-10.81
Experimental Group Post test	35	65.69	12.67	
Control Group Post test	35	29.29	12.28	12.20

The performance of the experimental group was higher than that of the control group in the post test with mean scores 65.69 and 38.03 respectively. The experimental group had a smaller standard deviation compared to that of the control group. This indicates that the experimental instructional technique was having a positive influence on the respondents‟ direct understanding on the items in the post test. The respondents were developing a clear understanding about the task requirements after instruction. The large value of standard deviation observed in the control group indicated persistence of variegated thinking despite the teacher centered instruction. The *z*-test was used to determine significance of difference of the means from the post test of the two groups. At a confidence level of 5% ($\alpha = 0.05$), the observed z - value lay beyond the tabulated rejection value, R: $|Z| > 1.96$. Thus the performance of the experimental group was statistically different from that of the control group.

The results from the current research resonates well with The House of Commons Science and Technology Committee (2002a), which for example, commented that, practical work, including fieldwork, helps students to develop their understanding of science, appreciate that science is based on evidence and acquire hands-on skills that are essential if students are to progress in science. And that, Students should be given the opportunity to do exciting and varied experimental and investigative work. The findings here clearly contradicts Osborne (1998) who argued that practical work 'only has a strictly limited role to play in learning science and that much of it is of little educational value'. Similarly, Hodson (1991) claims that: 'as practised in many countries, it is ill-conceived, confused and unproductive', is not supported by this study. Clearly, the results answer the research question that was posed earlier that; to what extent will practical work in science improve performance?

4.2: Research Question two

To what extent will regular practical activity in science promote and sustain the interest of learners in science?

The aim of this research question was to establish the effect of practical work on learners' interest and whether or not such interest can be promoted and sustained during science lessons. The results from the responses given by both the experimental group are summarized in the tables 3 and 4.

Table 3: Experimental group response on the interest developed during practical activity

ITEM	SA (N%)	A (N%)	NS (N%)	D (N%)	SD (N%)
4. Practical activities enhances my understanding in the topics treated in science	29(82.9)	6(17.1)	0(0.0)	0(0.0)	0(0.0)
5. I get excited during practical lessons and wish to do science activities in all lessons	20(57.1)	15(42.9)	0(0.0)	0(0.0)	0(0.0)
6. I participate actively throughout science lessons when it involves practical activity.	17(48.6)	15(51.4)	0(0.0)	0(0.0)	0(0.0)
7. I really get bored when we are to engage in practical activity	0(0.0)	0(0.0)	4(11.4)	21(60.0)	10(28.6
8. I always enjoy practical lessons anytime we are engaged in it	12(34.3)	17(48.6)	6(17.1)	0(0.0)	0(0.0)
9. I am motivated and my confidence increase when we do practical activities	15(42.9)	19(54.3)	1(2.9)	0(0.0)	0(0.0)
10. I think practical activity is a waste of time	0(0.0)	0(0.0)	0(0.0)	16(45.7)	19(54.3

Table 4: Control group response on the interest developed during practical activity

ITEM	SA (N%)	A (N%)	NS (N%)	D (N%)	SD (N%)
4. Practical activities enhances my understanding in the topics treated in science	5(14.3)	8(22.9)	15(42.9)	6(17.1)	1(2.9)
5. I get excited during practical lessons and wish to do science activities in all lessons	4(11.4)	6(17.1)	9(25.7)	14(40.0)	2(5.7)
6. I participate actively throughout science lessons when it involves practical activity.	5(14.3)	3(8.6)	10(28.6)	9(25.7)	8(22.9)
7. I really get bored when we are to engage in practical activity	6(17.1)	10(28.6)	11(31.4)	6(17.1)	2(5.7)
8. I always enjoy practical lessons anytime we are engaged in it	3(8.6)	9(25.7)	11(31.4)	9(25.7)	3(8.6)
9. I am motivated and my confidence increase when we do practical activities	3(8.6)	3(8.6)	12934.3)	10(28.6)	7(20.0)
10. I think practical activity is a waste of time	10(28.6)	16(45.7)	1(2.9)	6(17.1)	2(5.7)

Tables 3 and 4 shows the frequency (and percentages) of respondents from each of the experimental and the control groups on each concern. For every question that seeks the interest of learners on practical activity, the experimental group had more respondents scoring points that suggest that they had a more positive view concerning practical activities.

Table 2 indicates that the experimental group had more respondents 82.9% who understood the topics after instruction compared to the control group 14.3%. this definitely translated to their excitement derived from practical activities as 57.1% and 42.9% all strongly agreed and agreed respectively that they get excited during practical activities and wish to have practical lessons all the time. There were no respondents in the experimental group 0.0% who agreed that practical work in science is really boring compared to the control group 17.1% and 28.6% who strongly agreed and agreed respectively.

I participate actively throughout science lessons when it involves practical activity; responses to this question indicated that 48.6% of the experimental group felt that they could do this satisfactorily compared to only 22.9% of those in the control group.

After going through the course, 42.9% of the experimental group respondents reported that they were motivated and having their confidence increased compared to only 8.6% of the control group respondents. Large number of respondents of the control group 45.7% agreed that practical activity is a waste of time compared to 0.0% of the experimental group. The findings of this study concerning respondent formed interest concur with the observations of (Hodson, 1993; Amos &Boohan, 2002; Millar, 2002) that another useful method for enabling students to participate in the learning process is to conduct practical work and that Active participation can increase students' learning, understanding and motivation to learn. Kim and Chin (2011) have reported that practical work was a significant tool for developing students' scientific knowledge and habits of mind which concurs with the finding that practical work contributed to increased ability to understand the content in this study.

4.3: Research question 3

What locally available materials in the area of study affect teaching and learning of some science topics?

For the three months of teaching both groups, they were taken through topics in photosynthesis, mixtures, osmosis and diffusion. The instructional technique for the experimental group was that which emphasized a practical approach in teaching these topics. The researcher engaged the experimental group in some practical activities on some of the topics. The researcher also used other innovative ways to try and make the topics look more practical in nature by employing the use of well fitted local materials to demonstrate lessons for easy understanding. Most of the materials used were collected from the school environment by the students themselves and shaped into forms that could be used in place of standardized laboratory equipment.

Table 5: Topics and experiments during the term.

Topic	Experiment	Description	Practical details
Photosynthesis	1.	Testing a leave for starch	Boil leave, rinse in alcohol, and add few drops of iodine. Expect blue black coloration.
	2.	To show that oxygen is given off during photosynthesis	Place pond weed in a beaker with water. Cover with an inverted funnel Place NaHCO3 in water Use a splint of wood to test for oxygen
Mixtures (separating mixtures)	1.	Filtration.	Using funnel and filter paper to separate sand from water
	2	Distillation	Using locally designed set up to produce pure water.
Diffusion &Osmosis	1	Demonstrating diffusion in liquids	Using ink from a student's pen and a beaker of water to show how diffusion occurs
	2	Demonstrating osmosis in living cells	Using yam tuber and salt solution to demonstrate osmosis in living tissues

Most of the apparatus used during these practical activities were locally constructed from materials that were readily available in the school's environment by the students together with the researcher. The following apparatus and setups were improvised: Filtration, Distillation, separation of mixtures and common laboratory apparatus-beakers, stirrer, funnel, stand, test tube holder.

Fig 2

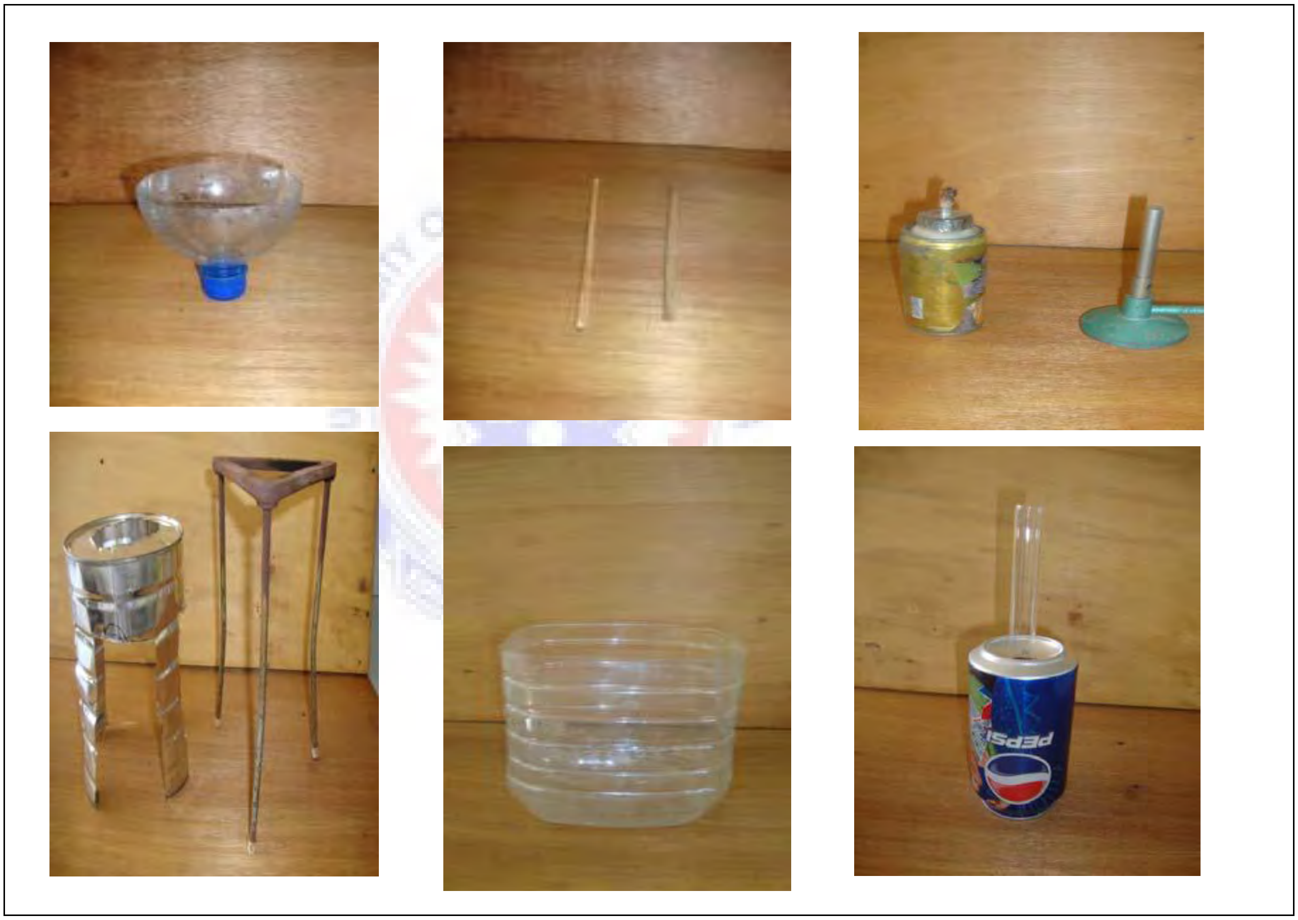


Fig 3


Locally designed set up
Standard laboratory set up
Locally designed set up

Table 6: Experimental group response on the effect of locally available materials on teaching and learning.

Item	SA N(%)	A N(%)	NS N(%)	D N(%)	SD N(%)
11. The use of local materials have since made me aware of things in my community that can be used in the classroom	23(65.7)	11(31.4)	1(2.9)	0(0.0)	0(0.0)
12. I get much confused when these local materials are used in place of standard laboratory equipment	0(0.0)	7(20.0)	4(11.4)	19(54.3)	5(14.3)
13. The use of local materials eliminates the fear of breaking things in the laboratory during practical activity.	9(25.7)	21(60.0)	5(14.3)	0(0.0)	0(0.0)
14. Using local materials like voltic containers, bottle tops works perfectly and makes the topic treated very easy to understand	7(20.0)	5(14.3)	17(48.6)	4(11.4)	2(5.7)
15. After going through the activities using the local materials, I am confident that I can do same on my own	23(65.7)	7(20.0)	3(8.6)	2(5.7)	0(0.0)

Table 5 illustrates the views of the experimental group on the effect of locally available materials on their learning. The experimental group participated in all the experiments.

The control group could easily have performed all the experiments since they did not require expensive apparatus. The experimental group reported having grown in confidence in setting up the equipment as 65.7% of the respondents strongly agreed that they have since become aware of useful things in their environments that are useful in for learning. In terms of their ability to apply what they learn, 65.7% strongly agreed that having gone through the activities using the local materials, they are confident that they can do same on their own. Again, 20.0% and 14.3% of the respondents strongly agree and agree respectively that the use of local materials in teaching makes the topics easy to understand. Majority of the respondents in the experimental group 54.3% strongly opposed the view that the use of locally available materials in place of standard laboratory equipment gets students confused. This could be an indication that improvisation during the activities might have helped them overcome some challenges during learning. This also could have been due to the greater exposure the experimental group had to practical work relative to the control group. Over two thirds of the same respondents confirmed that dealing with the locally available materials eliminates the fear of breakages in the school laboratory. This assertion could account for reasons as put forward by (Somerset, 1993) why it is possible to find in some cases twenty year old equipment kits still in their original packages. Musar, (1993) ; Dalgetyand GTZ, (1983) reported that standard laboratory equipment meant for use are sometimes safely locked up in the school cardboards and not used at all because the teacher is afraid he/she or the students will break it and that he/she will have to pay for it from his/her own pocket. The findings of the current study are in agreement with several existing findings on the use of locally available materials for teaching and learning. SCORE, (2008) has reported that having the right resources available at the right time is an obvious pre-requisite for high quality practical work. Yitbarek (2012) has expounded on the role of locally available materials in enriching the capacity of learners to observe, explain and do real science and increase the quality of learning. The current study found that teaching approaches that make use of locally available materials benefited the students even in situations where the conditions for teaching are not conducive.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Overview

This section of the study discusses the summary of findings and significant ideas and conclusions of the study.

5.1Summaryof findings

5.1.1 Research question one

The pre-test results of the two groups before the intervention showed that the two groups were of comparable ability with mean scores of 35.44 and 38.03 for the experimental and the control groups respectively. The experimental group however had their mean scores increased to 65.69 following the intervention. This clearly suggests that involvement in meaningful practical work contributes to improved performance in the topics from which the practical was derived. Practical work made the students keener on the content.

5.1.2 Research question two

To what extent will regular practical activity in science promote and sustain the interest of learners in science?

The main areas of interest here included whether or not they had some level of excitement during practical work, whether or not they were able to stay active during practical lessons, whether or not they get motivated with practical activities and also they really enjoy lessons with practical components.

The experimental had more respondents giving positive answers in terms of percentages to the questions posed as compared to the control group. 57% and 42.9% of the experimental group strongly agree and agree respectively that they get some level of excitement during practical lessons and 42.9% of same group confirmed that they are motivated and are able to participate actively throughout practical lessons. It stands to reason therefore that clearly; the waning interest in science at secondary school level can be checked and even reversed if the students are exposed to meaningful practical in the earlier secondary classes.

5.1.3 Research question three

What locally available materials in the area of study affect teaching and learning of some science topics?

During term one the respondents learnt about photosynthesis, transport in living organism and mixtures. The experiments that could have been used in accompaniment of the theory are indicated in table 3 in chapter four. The experimental group had the benefit of going through these practical activities. The responses from the investigation revealed that;

1. The use of local materials makes teachers and learners aware of resources around them that can stimulate creativity.
2. Experiments can be done with or without standard laboratory equipment.
3. Involvement in the designing the set up develops a sense of proud ownership and promotes a more frequent use.
4. Replacement of broken equipment is possible locally with technical or administrative problems.

5.2 Conclusions

The study investigated the effectiveness of practical work in some concepts of science. The specific conclusions from the findings of the study are:

1. Involvement in meaningful practical work contributes to improved performance in the topics from which the practical was derived. The experimental group's instructional technique had a positive influence on the respondents direct understanding on the items in the post test. The experimental group have had to appreciate the fact science is based on evidence since their understanding was based on personal experience of the process.
2. A significant difference was observed in terms of interest. Meaningful practical work is an effective way of teaching. Practical work can promote and sustain student's interest in learning science. The experimental group recorded positive responses in most of the areas including the fact that they have developed self-confidence in the topics treated and wished they do these activities for all science lessons. The practical activities have impacted positively on their love for science lessons as most of the respondents in the experimental group agreed that they are able to participate actively during science lessons.
3. The use of locally available materials in teaching science makes the subject matter and the method of instruction near at hand because the concepts relates well with learners own experience. The curriculum is more vital and meaningful when resources at hand are used in the classroom. The use of local available materials makes experimental lessons time very short and can be done with no or low financial input.

5.3Recommendations

The findings confirm that the use of practical work is an effective method in improving the performance learners. Thus, it is recommended that more practical work should be used when teaching Science. This requires that teachers of science undergo periodic training and be motivated to put additional effort into the preparation of practical work (demonstrations and experiments). The Education Departments need to seek and support those teachers with limited laboratory skills and encourage those who already have sufficient skills and experience to use practical work in science lesson delivery.

Science teaching approaches should create the space where students wrestle with an idea in their own minds until it becomes meaningful to them. Thus the strategy should seem to carry the students along by making them active participants in the learning process

Teaching of science should start with the use of familiar materials. Thus teachers should be train to use hand-tools so they can improvise, where possible, science equipment for practical work. This may give teachers confidence to set up low-cost practical work in places where there is limited equipment.

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APPENDICES

APPENDIX A

PRE-TEST

C703/02
March 2016
INTEGRATED SCIENCE
WRITTEN
2½ hours

ST. BERNADETTE'S TECHNICAL INSTITUTE – NAVRONGO

EXAMINATION UNIT

CERTIFICATE II CORE SUBJECTS EXAMINATION FOR TECHNICAL & VOCATIONAL INSTITUTES

WEDNESDAY	**INTEGRATED SCIENCE 2**	**09:00am - 11:30am**
3TH March, 2016		

[60 MARKS]

NAME OF INSTITUTE: ……………………………………………………

NAME OF CANDIDATE: ……………………………………………………

INDEX NUMBER: ……………………………………………………

1. A body of mass 40.0kg climbs a wall 2.0m high. What is the work done against gravity if g=10.0m^{-2}?

   A. 80.0J

   B. 160.0J

   C. 200.0J

   D. 800.0J

2. Which of the following quantities is not a vector quantity?

   A. Force

   B. Mass

   C. Velocity

   D. Weight

3. The inorganic mineral particles of the soil are derived from

   A. Decaying animals

   B. Decaying plants

   C. Parent rock

   D. Root nodules

4. The SI unit of power is

   A. Nms

   B. Nms^{-2}

   C. Nm^{-1}s^{-1}

   D. Nm^{-1}s

5. Which of the following structures is an organ?

   A. Alimentary tract

   B. Chloroplast

   C. Leaf

   D. Xylem vessel

6. Substances that can be broken down biologically by bacteria are said to be

   A. Biodegradable

   B. Colloids

   C. Detergents

   D. Digestible

7. Which of the following management practices is/are associated with poultry?

I. Breeding II. Castration III. Debeaking

A. I and II only

B. I and III only

C. II and III only

D. I , II and III

8. The causative organism of elephantiasis is

A. Bacteria

B. Fungus

C. Virus

D. Worm

9. Erythrocytes do not filter into the Bowman's capsule because they

A. Are selectively redirected into the glomerulus

B. Have relatively high molecular weight

C. Biconcave in shape

D. Have hemoglobin centrally located in them

10. The process of removing undigested food material out of the body is termed

A. Egestion

B. Excretion

C. Ingestion

D. Secretion

11. Which among these is not a pathogenic disease?

A. Ulcer

B. Malaria

C. Yaws

D. Bilharzias

12. Which of these diseases can be inherited from affected parents

A. Rickets

B. Kwashiorkor

C. Tuberculosis

D. Diabetes

13. The following science apparatus can be used to accurately measure volume of liquids except

A. Burette

B. Retort stand

C. Measuring cylinder

D. Pipette

14. Which among the following farm animals does not have a four chambered stomach?

A. An ewe

B. A sow

C. A bull

D. A doe

15. The true stomach of the ruminant is the

A. Gizzard

B. Abomasum

C. Proventriculus

D. Caecum

16. When heat is applied on one end of a metal, it slowly travels to the other part and this phenomenon is termed as

A. Conduction

B. Heat distribution

C. Heat transfer

D. Convection

17. Digestion ….. begins in the mouth when saliva is mixed with food.

A. Protein

B. Vitamins

C. Fats and oils

D. Carbohydrates

18. The body's ability to fight and resist diseases is as a result of the presence of the…

A. white blood cells

B. Red blood cells

C. Plasma

D. Water

19. Plants lose water to the atmosphere through a process known as

A. Excretion

B. Transpiration

C. Transplanting

D. Sweating

20. Atoms that have excess electrons are called…

A. Ions

B. Anions

C. Cations

D. Inert atoms

21. Denitrifying bacteria obtains energy from breaking down nitrates into nitrogen. An example of such bacteria is

A. Nitrobacter

B. Clostridium

C. Nitrosomonas

D. Azotobacter

22. Which of these natural occurrences fix nitrogen into the soil?

A. Raining

B. Leaching

C. Cloud formation

D. Lightning

23. The colouring pigment that gives the skin its color is known as

A. Melanin

B. Dermis

C. Pressure receptors

D. Heat receptors

24. The source of energy for the cell is……….

A. Vacuole

B. Mitochondrion

C. Chloroplast

D. Nucleus

25. The interval between fertilization and delivery in farm animals is termed as

A. Perspiration

B. Parturition

C. Mating

D. Gestation

26. Which among the following is not a monogastric?

A. Rabbits

B. Swines

C. Goats

D. Turkeys

27. The simplest way of removing hardness in water in large quantities will be

A. Addition of washing soda

B. Boiling

C. Cation exchange

D. Distillation

28. Examples of chemical weathering processes include the following except

A. Coagulation

B. Reduction

C. Hydration

D. Oxidation

29. Liquid oral drugs are administered to ruminants using the instrument known as

A. Syringe

B. Medicine shooter

C. Dipping ditches

D. Drenching gun

30. A strong acid is one which

A. Has a corrosive power

B. Has a low concentration of water

C. Gives high concentration of hydrogen ions in solution

D. Gives high concentration of hydroxide ions in solution

31. Which of the following controls all the characteristics of an organism/

A. Gene

B. Chromosome

C. RNA

D. Peptide

32. When water vapour turns back into liquid the process is called

A.Evaporation

B.Condensation

C.Precipitation

D. Sunshine

33. Where does precipitation fall from?

A.Airplanes

B.Sky

C.Clouds

D. Trees

34. The water cycle is

A. The continuous movement of water

B. How water goes through a house

C. The stuff in water

D. The shape of the water molecules

35. Resistance in a conductor can be measured with the help of

A.Voltmeters

B.Ammeters

C. ohmmeters and resistance bridges

D. All of the above

36. What is diffusion?

A. The movement of particles from low concentration to high concentration

B. The movement of particles from high concentration to low concentration

C. Active movement of particles, requiring energy from respiration

D. Transfer of water molecules across active membrane

37. Which of these three liquids has the highest water potential?

A. Pure water

B.10% sucrose solution

C. 20% sucrose solution

D. porridge

38. Which part of the cell controls the movement of substances in and out of the cell?

A. nucleus

B. cell membrane

C. Cell wall

D. cytoplasm

38. Which part is found in plant cells but not in

animal cells?

A. Chloroplast

B. Nucleus

C. Cell membrane

D. None of the above

39. Which organism is used in the production of

yoghurt from milk?

A. Streptococcus pneumoniae

B. Lactobacillus bulgaricus

C. Plasmodium falciparum

D. Salmonella

40. What do animals, fungi and viruses have in common?

A. They consist of cells

B. They cannot carry out photosynthesis

C. They do not have cell walls

D. None of the above

INTEGRATED SCIENCE 2

ANSWER TWO QUESTIONS FROM THIS SECTION

1. (a) (i) Define latent heat of fusion.

(ii) Distinguish between latent heat of fusion and latent heat of vaporization

(b) Consider the following diseases;

i typhoid

ii measles

In the form of a table, state the causative agent, mode of transmission and one Symptom of each disease.

(c) State one importance each of the following management practices in animal Production.

(i) Debeaking

(ii) dipping

(iii) culling

(d) Describe briefly the process of fertilization in flowering plants

2. (a) (i) Distinguish between density and relative density

(iv) A solid material of mass 22.2g was put into a measuring cylinder of containing water. If the level of water rose from15.3 cm^3 to $24.5cm^3$ calculate the density of the material.

(b) (i) What is artificial insemination?

(i) State four signs shown by an animal on heat

(c) Name the most appropriate instrument for taking each of the following measurements;

i. Diameter of a wire of radius 1.8mm

ii. Length of a piece of wood 11.5m long

(d) (i) State the major components of soil

(ii) Mention two farming practices that helps to prevents soil erosion.

3. (a) (i) What is meant by excretion?

(v) Give two excretory products of each of the following organs

(α) Lungs

(β) Kidneys

(γ) Skin

(b) Give a function each of the following blood cells.

i. erythrocytes

ii leucocytes

(c) Describe the water cycle.

(d) (i) What is the difference between normal salt and an acid salt

(ii) Define a base and give two examples.

4. (a) (i) Define hardness of water

(ii) What causes hardness of water?

(b) (i) Draw and label a plant cell (LABLE CORRECTLY FOUR PARTS)

(ii) Give one function of any two labelled parts in (bi) above

(c) (i) What is a Ruminant?

(ii) Tabulate three differences between the extensive and intensive systems of keeping farm animals

(d) (i) mention the constituents of sweat?

(ii) Use a balanced chemical equation to define Neutralization.

APENDIX B

STUDENTS QUESTIONNAIRE

THE EFFECT OF PRACTICAL ACTIVITY IN PROMOTIN AND SUSTAINING LEARNERS INTEREST INSCIENCE

I appreciate your time taken in the completion of this questionnaire. Please be truthful and respond to the best of your ability. Names and other identifications are not required hence be assured that whatever is presented here will be confidential.

Kindly read and provide the required information

A. Background information

Tick appropriately [/]

1. Gender maele [ ] female [ ]
2. Age [ ]
3. What is your pre entry qualification? SSSCE [ ] WASSCE [ ]

   Others ; please specify

   ……………………………………………………………………………………………………

B. Students interest in science after going through practical activity

Please tick [/] the option that best reflects how you associate with each of the following statements. Rating scale: Strongly Agree (SA), Agree (A), Not Sure (NS), Disagree(D), Strongly Disagree(SD

Statement	SA	A	NS	D	SD
4. Performing practical work enhances my understanding in the topics treated.					
5. I get excited whenever we perform an activity and wish we do science activities in every science lesson					
6. I participate actively throughout the lesson once it is an activity					
7. I really get bored anytime we are to engage in science practical work.					
8. I always enjoy lesson that involve us in practical activities					
9. I am motivated and my confidence also increase when we do practical					
10. I think science practical work is a waste of time					

C. Effect of Locally Available Material on the Teaching and Learning of Some Science Concepts.

Please tick [/] the option that best reflects how you associate with each of the following statements.

Statement	SA	A	NS	D	SD
11. The use of bottle tops and tooth picks to teach balancing of equations makes the lesson real and easy for me					
12. The use of these local materials have since made me become aware of things in my community that can be used in the classroom					
13. I get much confused when these things are used in the classroom.					
14. The use of these local materials eliminates the fear of breaking things at the lab after all they are easy to find					
15. Using a cut-open voltic container worked just like a glass beaker in the lab and is easy to use					
16. After going through the osmosis experiment I can now do it at home after all I can use my own drinking cup					

APPENDIX C

POST-TEST

END OF TERM EXAMINATIONS

INTEGRATED SCIENCE-BAII &BSII

TIME 1:30MIN

There are 15 questions on this first section. Choose the alternative that best completes the statement or answers the question

1. The movement of molecules from an area of high concentration to an area of lower concentration is known as:

A Osmosis

B Diffusion

C Active Transport

D Phagocytosis

2. The movement of water molecules from an area of high concentration to an area of

low concentration through a semi permeable membrane is known as :

A Active Transport

B Diffusion

C Phagocytosis

D Osmosis

3. The movement of molecules from an area of low concentration to an area of high

concentration against the concentration gradient is known as :

A Active Transport

B Osmosis

C Diffusion

4. Identify the process that requires energy in order to take place :

A Osmosis

B Diffusion

C Active Transport

5. Essential salts dissolved in body fluids are known as :

A Phagocyte

B Erythrocytes

C Electrolytes

D Podocytes

6. The system of the body that acts to collect tissue fluid that is not absorbed directly back into the bloodstream is :

A Digestive system

B Respiratory system

C Endocrine system

D Lymphatic system

7) If photosynthesizing green algae are provided with CO2 synthesized with heavy oxygen (18O), later analysis will show that all but one of the following compounds produced by the algae contain the 18O label. That one is

A) PGA.

B) PGAL.

C) glucose.

D) O2.

8) Where does the Calvin cycle take place?

A) stroma of the chloroplast

B) thylakoid membrane

C) cytoplasm surrounding the chloroplast

D) chlorophyll molecule

9) In any ecosystem, terrestrial or aquatic, what group(s) is (are) always necessary?

A) autotrophs and heterotrophs

B) producers and primary consumers

C) photosynthesizers

D) autotrophs

Theodor W. Engelmann illuminated a filament of algae with light that passed through a prism, thus exposing different segments of algae to different wavelengths of light. He added aerobic bacteria and then noted in which areas the bacteria congregated. He noted that the largest groups were found in the areas illuminated by the red and blue light.

11) What did Engelmann conclude about the congregation of bacteria in the red and blue areas?

A) Bacteria released excess carbon dioxide in these areas.

B) Bacteria congregated in these areas due to an increase in the temperature of the red and blue light.

C) Bacteria congregated in these areas because these areas had the most oxygen being released.

D) Bacteria are attracted to red and blue light and thus these wavelengths are more reactive than other wavelengths.

E) Bacteria congregated in these areas due to an increase in the temperature caused by an increase in photosynthesis.

12) An outcome of this experiment was to help determine

A) the relationship between heterotrophic and autotrophic organisms.

B) the relationship between wavelengths of light and the rate of aerobic respiration.

C) the relationship between wavelengths of light and the amount of heat released.

D) the relationship between wavelengths of light and the oxygen released during photosynthesis.

13) Which of the following statements *best* describes the relationship between photosynthesis and respiration?

A) Respiration is the reversal of the biochemical pathways of photosynthesis.

B) Photosynthesis stores energy in complex organic molecules, while respiration releases it.

C) Photosynthesis occurs only in plants and respiration occurs only in animals.

D) ATP molecules are produced in photosynthesis and used up in respiration.

14. The cell theory is one of the unifying themes of biology. Which of the following statements would be part of the cell theory?

A) All life is made of cells.

B)Cells are the smallest units of life.

C) Cells come from pre-existing cells.

D) All of the above

15. A homogenous liquid mixture of two or more substances is called

A. Solution B Solute

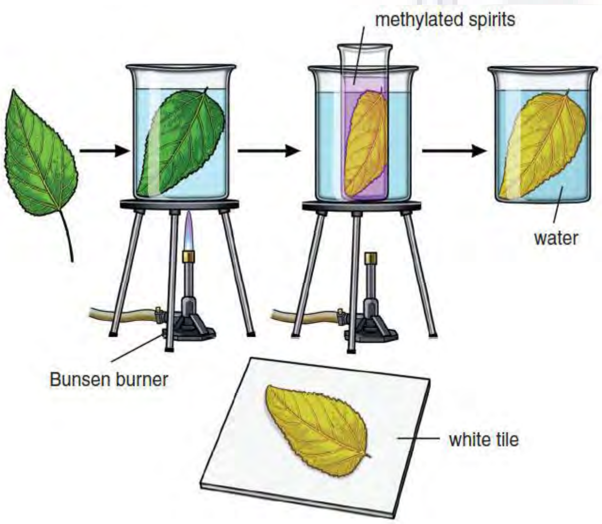
C Solvent D. Glue

TEST OF PRACTICALS

Study the diagrams carefully and provide the answers.

1. During an investigation a pot plant was placed in a dark cupboard for three days. One of the green leaves from the pot plant was then partially covered with tin foil. After the plant had been exposed to sunlight for two days, the leaf was removed from the plant and treated as shown in the diagram below.

Study the diagram and answer the questions that follow



I. Name the TWO chemicals used in the process.

II. Why are these substances used in this investigation?

III. What results are/is expected at the end?

IV. Name ONE precaution you would take whenperforming this investigation.

2. Examine the diagram. Complete the table correctly **matching** the labels **A – D** in the diagram with the words in the table.

Thermometer,	
Round bottomed flask,	
Tripod	

Bunsen	
Condenser	
Beaker	

3. Describe, with the aid of a labelled diagram, how you would **separate a mixture of sand and water**.

Equipment:

____

____

____

Procedure:

____

____

____

____

____

Result:

____

____

____

APPENDIX D1

ANSWERS FOR PRE TEST

Objectives

1A 2C 3C 4B 5C 6A 7B 8D 9A 10A 11A 12D
13B 14B 15B 16A 17D 18A 19B 20C 21C 22D 23A
24B 25D 26C 27B 28A 29D 30C 31B 32A 33C 34A
35C 36A 37A 38A 39A 40A

1 ai)the energy that is required to change the phase of solid to liquid.

ii) Latent heat of fusion loosens intermolecular bonds of substances while latent heat of vaporization produces cooling effect

b)

Disease	***Causative Agent***	***Mode of Transmission***
i. Typhoid	bacteria	water borne
ii. Measles	viruses	air borne

c) i. debeaking -prevent cannibalism

ii.dipping -prevent ticks infestation

iii. culling - maximise economic gains

d) The male gamete from the pollen tube fuses with the egg nucleus in the ovule to form a

zygote. The zygote develops into an embryo.

2. ai)The deposition of carefully selected sperm of a proven male into the vagina of a female

animal on heat.

ii. –making noise, reddening of the vulva, restlessness, loss of appetite, mounting other animals

b i) Density is defined as mass per unit volume of a substance and relative density is the ratio of the density of a substance to the density of a given reference material.

c. i. Micrometer screw gauge

ii. Meter rule

d.i). rocks, water, air and organic matter.

4. a.i). Excretion is the process by which metabolic waste and non-useful products are eliminated from the body of an organism.

ii) Lungs	carbondioxide and water
Kidneys	water and mineral salts
Skin	water and urea

b. i) Erythrocytes.	Transport oxygen
ii) Leucocytes	fight infections

c. i) The continuous movement of water on, above and below the earth surface.

d. Normal salt – Is formed when all the hydrogen ions are replaced.

Acid salt- is formed when there is partial neutralization of the polyprotic acids

APPENDIX D2

ANSWERS FOR END OF TERM EXAM

1 .B 2.A 3.A 4.C 5.C 6.D 7.D

8.A 9.D 10.B 11.C 12.D 13.B 14.D

15.A

TEST OF PRACTICALS

1.

I. –Alcohol and iodine

II. Alcohol removes the chlorophyll content in the leaf

Iodine causes colour change

III. Blue-black coloration indicating the presence of starch

IV. Do not use hands to remove leaf out of hot water

2.

Thermometer,	
Round bottomed flask,	A
Tripod	B
Bunsen	
Condenser	C

Beaker	D

3.

Equipment:

Method used –Filteration.

i. Funnel

ii. Beaker

iii. Filter paper

iv. stand

4. Procedure:

Fold the circular paper in half and the fold in half a second time. Open the paper to make a cone that will be put into the filter funnel. Hang the funnel on the edges of the beaker. Pour the mixture (sand and water) into the funnel and wait.

Result:

After few minute depending on the amount of mixture, the water will be in the beaker leaving the sand in the filters.

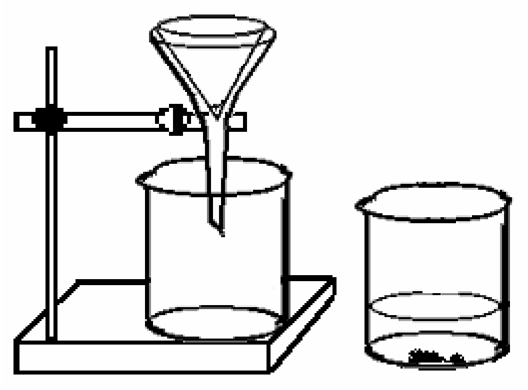


DIAGRAM- FILTRATION