UNIVERSITY OF EDUCATION, WINNEBA

EFFECT OF PRACTICAL ACTIVITIES ON STUDENTS' ACADEMIC ACHIEVEMENT IN SOME SELECTED TOPICS IN INTEGRATED SCIENCE

ALFRED TAMPAA

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ALFRED TAMPAA

(202113948)

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DECLARATION

Student's Declaration

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TAMPAA, hereby declare that this thesis, with the exception of quotations and references contained in published and unpublished works, duly identified and acknowledged is entirely my own original work, and that it has not been submitted either in part or in whole, for another degree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

SIGNATURE: ……………………………….

DATE: ………………………………………..

Supervisor's Declaration

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

NAME OF SUPERVISOR: PROF. KODJO DONKOR TAALE

SIGNATURE: ……………………………….

DATE: ………………………………………..

DEDICATION

To my wife Matilda Gandaabie and our children Alexander and Aurelia. To you all, I dedicate this thesis to you.

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First and foremost, I give special thanks and glory to the Almighty God for giving me the grace, good health and wisdom to complete this thesis successfully.

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ABSTRACT

The study investigated the effect of practical activities on students' academic achievement in some selected topics in Integrated Science at Wa Islamic Senior High School in Upper West Region of Ghana. An action research design was employed for the study and the accessible population for the study were SHS 2 Integrated Science students. The intact class was made up of a sample size of 50 students. The instruments used were student achievement test (pre-test and post-test) and classroom observational schedule. The content validity of the main instrument was determined with the help of the supervisor of the study. The student achievement test and classroom observational schedule were used to obtain the data in the study. The data collected were analysed using t-test statistics. The study revealed that the use of practical activities is more effective in enhancing students' academic achievement in science. It was also found that frequent organisation of laboratory practical activities and regular exposure of students to laboratory practical exercises promote the development of scientific inquiry of students. Also, gender had significant influence on students' performance when taught with the use of practical activities. It was concluded that effective use of practical activities is a viable teaching method for enhancing students' academic performance in Integrated Science. It is recommended that science teachers should adopt the use of practical activities alongside the theory to enable students acquire the needed skills for practical works. Also, students should be given that chance to practice the practical laboratory skills acquired regularly to enable them carry out practical works successfully on their own.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter talks about the background to the study. It also includes statement of the problem, purpose and objectives of the study, research questions and significance of the study, delimitations and limitations of the study, definitions of operational terms and abbreviations, and organisation of chapters.

1.1 Background to the Study

The relevance of science to humanity in giving mankind the ability to explain everyday phenomena and to develop technology cannot be overemphasised. In this 21st Century when the whole world is fast becoming a global village, the study of science and technology becomes mandatory. Okafor (2002), opined that the growth of any nation be it economically, socially or politically, is determined to a great extent, by its advancement in science and technology. It is an undeniable fact that any country which wants to develop must place some emphasis on science education.

The past and current governments of Ghana, seeing the need for science and technology, deemed it fit to reform the hitherto arts-based educational system, to include more robotic, Science, Technology, Engineering, Arts and Mathematics (STEAM), and vocational courses. The aim is to raise the needed manpower to lead in the nation's technological advancement and the science teachers are responsible in helping every child acquires these knowledge and skills also are expected to teach inquiry science to the young ones.

Unfortunately, despite the government's drive to draw more students to science, especially at the second cycle levels, more students keep running away from it. O'Connor (2002) identified the use of inappropriate teaching methods as one of the factors that contribute to the low participation and performance of students in science. The teaching methods used are not practical enough and that teachers make very little efforts to relate the concepts learnt and the examples or illustrations used to real life, especially within the context of the students' own lives and environment. This has a negative effect on student's interest and motivation to the study of science subjects. Danso (2010) indicated that teachers favour teacher centered, knowledge-based teaching methods that leave little room for learners' participation. The most commonly used methods at both basic and secondary levels have been found to be lecturing; question and answer; explanations of procedures and note giving, in that order (O'Connor, 2002). Little practical work is done due to shortage of equipment and consumables and the development of a science way of thinking is abandoned in favour of the learning nomenclature, definitions and stock standard procedures (O'Connor, 2002).

Science is experimental in nature and the practical work helps to enhance scientific knowledge through the process of science (observing, classifying, measuring and interaction with objects and events of scientific interest) (Njelita, 2008). Therefore, there is need to prepare students practically in the laboratory as well as develop some follow-up activities. These may enrich and enhance the whole practical experience and enable it to contribute more effectively to the overall learning of students in Integrated Science. It would be rare to find out any institution of education without substantial component of laboratory activity. However, it is taken for granted that experimental work is a fundamental part of any science course and this is especially true for Integrated Science. Ogunkola and Fayombo (2009) indicated that practical work is the back-bone of effective science teaching and learning. Alebiosu cited in Ogunkola and Fayombo(2009) opined that science is experimental and it's teaching specially focuses on making students learn through working of hands, brains and the heart.

A study carried out by Adu-Gyamfi (2013) in Ghana reveals that students' lack of interest in science is anchored on the time consuming and less practical nature of teaching and learning science. The science teachers are therefore required to design teaching sequences with appropriate teaching pedagogies that have potential to develop students' interest in the subject (Ajaja, 2017). The teaching of science should provide opportunities for students from seeing science as a school activity, to understanding the nature and technical activity beyond the classroom experience (Tufuor, 2007).

Mwangi, (2016) argued that science practical work forms 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 improve in science performance and progress in science. Students should be given opportunity to do exciting and varied experiments and investigate work. The report also argues that science practical work is a vital part of students' learning experiences and should play an important role in improving students' performance in science. Some sections of the science community, industry and business have expressed concerns that schools in general are not doing enough practical work and that its quality is uneven (Abraham & Millkar, 2008).

In Ghana, many efforts such as provision of trained science teachers, construction and equipping of science laboratories, provision of the necessary teaching and learning resources and initiating projects like Robotics clubs, STEAM, Science fair and others have been made to improve the performance in science. Despite all these various educational improvement efforts of government, there appears to be a continuous annual poor academic performance of students in Integrated Science especially at the West African Senior School Certificate Examination (WASSCE) level (Okebukola, 2006). In Ghana, a study conducted by Abreh et *al* (2018) showed the failure rate in Integrated Science was in the neighbourhood of 30% for each of the years of 2007 to 2009, 2014, and 2015. Alarming reports still continue to come from the examination body such as West African Examinations Council (WAEC, 2020) concerning poor performance of students in science. Integrated Science recorded a decline in the performance of candidates at Grades A1 to C6 in 2020 as compared to 2019 as follows: Integrated Science (63.17% in 2019 to 52.53% in 2020) (Teye-Cudjoe, 2020).

The researcher's classroom observation of students' performance in Integrated Science reveals no difference from the mean score data from the Chief Examiners' reports from 2019 to 2020 (WAEC, 2020).

A number of research findings from Akpa (2008), and Ajaja (2011) show that several factors are responsible for the poor achievement of students in science related subjects such as practical drawing, labelling, handling of apparatus like ammeters, voltmeters, pipettes, burette etc. for carrying out certain measurements in science practical work. Among these factors as observed by other researchers are students' poor understanding of the basic concepts in science (Chukuneke, 2005), the use of traditional lecture method approach by science teachers (Ndioho, 2005), students' poor attitude towards practical work in science (Orkpo, 2006).

Over the years, many have argued that science cannot be meaningful to students without worthwhile practical experiences or practical activities in the school laboratory (Mamhok-Naaman, 2007). Typically, the term practical work means experiences in school settings where students interact with materials to observe and understand the natural world (Hofstein, 2004). The practical works are designed and conducted to engage students individually or in small groups, a method referred to as class experiment or in large group demonstration settings, which is known as teacher demonstration method.

A study in Israel (Trumper, 2006) showed that boys and girls of the same age tend to have different attitudes to similar teachings styles. On the other hand, a study by Kibirige and Tsamago (2013) shows that the attitudes of boys and girls towards science are not different when using similar methods.

Science learning is practical-oriented and requires practical activities in the laboratory. It requires broad-based experiences to widen students' knowledge in a world of abundance of choices and opportunities to give meaning to learning (Nwagbo, 2016). It also employs experiments using enriching learning materials to equip students with appropriate knowledge, skills, attitudes and behaviours. Achimugu (2014) stated that science learning involves experimentation that uses hands-on and minds-on activities for better understanding. This implies that experimental methods enable students to verify theories, laws, and principles surrounding science phenomena.

The objectives of studying Integrated Science in Senior High School as a life science in Ghana contained in the SHS2 Integrated Science (2010) syllabus include among others; understanding basic science concepts and acquisition of experimental and process skills to meet the requirements of everyday living and also provide adequate foundation for the study of other subjects and for those who wish to pursue further education and training in science related vocations. These objectives require that science should be learnt through experimentation by doing practices and making thorough observations that give meaning and relevance to understanding science. Based on these objectives, students' thinking capacity must be developed to widen interest and curiosity to think creatively. Having known some of these objectives, it is obvious that no concept in Integrated Science should be learnt in abstraction but practically by subjecting such concepts to experiments, testing, observing and verifying problems experimentally. It is important therefore, to give effective interpretation of existing phenomena and to gain useful insight into science as a life using appropriate practical activities (Njelita, 2008).

Teaching of science is said to be effective when resources such as laboratory practical activities, diagrams, charts, models, field works and real objects are efficiently utilised to explain the subject matter (Nwagbo, 2016). Practical activities in science are essentially important for concretising theoretical classroom learning experiences and stimulating the students urge to study science. It also provides opportunity for students to interact with materials and ideas, and thereby stimulate the development of affective and psychomotor dimensions of learning alongside with the cognitive dimension in order to ensure an all-round and comprehensive development of the student (Agbowuro, 2006).Practical activity in science could be seen as a method that could be adopted to make the task of teaching Integrated Science more concrete or real to students as opposed to theoretical or abstract presentation of principles, facts and concepts.

These records necessitated the need to determine if there would be effect on SHS2 students' performance in Integrated Science when practical activities were incorporated in the teaching and learning process of Integrated Science.

1.2 Statement of the Problem

The current state of teaching and learning of science in Ghana is poor. Studies show that many of our students tend to learn science by rote method and hence lack understanding of science concepts since no meaningful learning occurs (Azure, 2005). The quality of science teaching and learning in basic, secondary and tertiary institutions in Ghana has therefore been criticised by parents, science educators, technocrats and government (Azure, 2005). The poor teaching and learning of Integrated Science in Ghanaian schools has reflected in the poor performance of Ghanaian SHS students in the WASSCE that disqualify them from gaining admission into the tertiary institutions for further studies (Entsuah-Mensa, 2004). This has also accounted for the enrolment of students with weak grades in science and mathematics into Colleges of Education (Anamuah-Mensah & Asabere Ameyaw, 2011).

Perhaps this low performance in science can be attributed to the fact that Integrated Science practical work has not been given a central and distinctive place in the teaching and learning of Integrated Science at the SHS level (Baiden & Hanson, 2020). Again, Integrated Science Chief Examiners' reports have indicated that the performance of candidates in Integrated Science has recorded a decline at Grades A1 to C6 in 2020 as compared to 2019 as follows; 63.17% in 2019 to 52.53% in 2020 West African Senior School Certificate Examination (WASSCE). This weakness was attributed to students' inability to understand some Integrated Science concepts theoretically due to inadequate exposure to practical work. The researcher's classroom observation of students' performance in Integrated Science reveals no difference from the mean score data from the Chief Examiner's report from 2019 to 2020 (WAEC). Many science teachers also teach theory aspect of science and pay little or no attention to practical activities which will give their students opportunity to practice and develop their thinking and science process skills (Azure, 2005). Therefore, this study sought to investigate the effect of practical activities on SHS 2 students' performance in Integrated Science at Wa Islamic SHS in a bid to improve the academic achievement in the subject.

1.3 Purpose of the Study

The purpose of this study was to investigate the effect of practical activities on SHS 2 students' performance in Integrated Science at Wa Islamic SHS in the Wa Municipality of the Upper West Region of Ghana.

1.4 Objectives of the Study

Specifically, the study sought to;

1. Determine the effect of practical activities on SHS 2 students' performance in Integrated Science.
2. Use frequent organisation of practical activities to develop and improve upon the scientific inquiry skills of students.
3. Determine the difference between practical activities on male and female students' performance in Integrated Science.

1.5 Research Questions

The study sought to answer the following questions;

1. What is the effect of practical activities on SHS 2 students' performance in Integrated Science?
2. How can frequent organisation of practical activities aid in developing the scientific inquiry skills of students?
3. What is the difference between practical activities on male and female students' performance in Integrated Science?

1.6 Research Hypotheses

The following research hypotheses were generated and tested at significance alpha level of 0.05.

H_o1: There is no significant difference between the post-test mean score and the pre-test mean score on SHS2 students' performance in Integrated Science.

H_o2: There is no significant difference between practical activities on male and female students' performance in Integrated Science.

1. 7 Significance of the Study

The study attempted to provide evidence on the effect of practical activities on learners' performance in Integrated Science at Wa Islamic SHS. By so doing, the findings of this study may be added to existing body of knowledge about the role and effect of practical activities in the teaching and learning of Integrated Science. Using this knowledge, the teachers of science and science educators may be able to maximise the benefits of using the effect of practical activities as a teaching and learning strategy. The findings may give some necessary feedback to science teachers in the Colleges of Education, will probably improve on the training of science teachers. This may in turn boost the teaching of science at the basic and secondary levels which may lead to higher performance at WASSCE. The study may be of immediate benefit to those developing basic level and second cycle science curriculum for example, the National Council for Curriculum and Assessment (NaCCA) of the Ministry of Education. The study may also bring out suggestions and ways of inspiring and teaching science students in Ghanaian schools.

1.8 Delimitations of the Study

The research was restricted to SHS 2 students of Wa Islamic SHS in the Upper West Region of Ghana. This was because SHS 1 students would be out of school for their vacation and SHS 3 students would be preparing for their Mock examination and WASSCE. Additionally, the study was limited to some selected topics from the components of Integrated Science in the SHS 2 syllabus.

1.9 Limitations of the Study

According to Best and Kahn (1989), limitations are conditions beyond the control of the researcher that could place restrictions on the conclusion of the study and its application. Time and financial constraints posed a serious problem for the research. The time allocated for Integrated Science on the school time-table was not enough to favour the intention and expectations of the study. Advance measures such as using free or library periods on the time-table as well as weekends were utilised for the study so that the intention and expectations of the work would not be affected.

1.10 Definitions of Terms and Abbreviations

CAS: Correct Acquisition of Skills

NaCCA: National Council for Curriculum and Assessment

NAS: No Acquisition of Skills

PAS: Partial Acquisition of Skills

PRACTICAL ACTIVITIES: are the specific tasks to be carried out in the classroom or in the laboratory

SAT: Student Achievement Test

SHS: Senior High School

SRCM: Science Resource Centre Manual

SPSS: Statistical Package of Social Sciences

STEAM: Science, Technology, Engineering, Art and Mathematics

WAEC: West African Examinations Council

WASSCE: West African Senior School Certificate Examination

1.11 Organisation of the Study

This research is presented in five chapters. Chapter One presents the Introduction to the study, including the Background to the study, Statement of the Problem, Purpose and Objectives of the study, Research Questions, Significance of the study as well as the delimitations and Limitations of the study. Chapter two basically presents the Review of related Literature of the study and Chapter three deals with the Methodology for conducting the study, whilst Chapter four focused on the analysis and presentation of data collected. The last chapter (Chapter five) dealt with summary of key findings, conclusions, recommendations and suggested areas for further research.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.0 Overview

This section deals with the review of the related literature. The review is organised under the following subheadings;

1. Senior High School Integrated Science Instruction
2. Performance in Senior High School Integrated Science
3. Nature of Integrated Science Practical Activities
4. Concept of Laboratory Practical Work
5. Aims and Objectives of Laboratory Practical Works at Senior High
6. The Importance of Laboratory Practical Works in Science Education
7. The Frequency of Integrated Science Practical Activities and Students' Performances
8. Gender and Performance in Senior High School Integrated Science
9. Scientific Inquiry Skills to be developed for Practical Work
10. Aims of Science Resource Centre Manual
11. Theoretical Framework
12. Summary of the Literature Review

2.1 Senior High School Integrated Science Instruction

Instruction in Integrated Science is done through practical activities and theory work. Typically, the term practical work means experiences in school settings where students interact with materials to observe and understand the natural world. The practical activities are mainly carried out as student's experiments in the laboratories or in as teacher demonstrations either in laboratories or in classrooms, while theory is often done in the classroom (Twoli, 2006). In secondary schools, laboratory activities are designed and conducted to engage students individually, or in small groups (student experiments) and in large group demonstration settings (teacher demonstrations) (Mamhok-Naaman, 2007). Successful learning of Integrated Science depends partly on correct use of a teaching method whose activities target most learning senses. Since Integrated Science is a subject that encourages 'hands on' experiences, more practical oriented modes of instruction should be selected (Twoli, 2006).

Practical work is a very prominent feature of school science in many countries and a high proportion of lesson time is given to them. Science practical works are very much a characteristic of the school science curriculum. They have been part of school science curriculum for over a century, and their place in Integrated Science lesson has often gone unquestioned (Bennet, 2003). For example, the West African Examinations Council (WAEC) syllabus had over the years recommended that the teaching of all science subjects listed in the syllabus should be practical based, and after several decades of emphasising the assumed importance of practical work in science teaching and learning, the importance became elevated to the level of a dogma (Abimbola, 1994). Similarly, Hodson (1993) argued that, "teachers have been socialised by the powerful, myth-making rhetoric of the science teaching profession that sees hands-on practical work in small groups as the universal panacea - the route to all learning goals and the educational solution to all learning problems."

Like other sciences, Integrated Science teaching and learning is supported by laboratory experiments (practical sessions) (Reid & Shah, 2007). Integrated Science practical classes (experiments) are believed to help students in understanding theories and chemical principles which are difficult or abstract (Lagowski, 2002). Moreover, practical work offers several opportunities to students such as: handling of chemicals safely and with confidence, acquiring hands-on experience in using instruments and apparatus, developing scientific thinking and enthusiasm to Integrated Science, developing basic manipulative and problem solving skills, developing investigative skills, identifying chemical hazards and learning to assess and control risks associated with chemicals (Lagowski, 2002; Carnduff & Reid, 2003).

However, Hofstein (2004) argues that research has failed to show a simplistic relationship between experiences provided to the students in the laboratory and learning Integrated Science. There are concerns about the effectiveness of laboratory work in helping the students understand the various aspects of scientific investigation (Lazarowitz & Tamir, 1994; Schwartz., 2004). Teachers usually want to develop student's higher order thinking skills, like critical thinking, through laboratory work; but to what extent they can achieve this is controversial (Bol & Strage,1996; Ottander & Grelsson, 2006). Therefore, it is important to analyse the purposes related to laboratory work, as the purposes need to be well understood and defined by teachers and students alike for the Integrated Science practical work to be effective.

Traditionally, Integrated Science courses at all levels have included instruction in laboratory settings where students follow procedures directing them to mix chemicals, make measurements, analyse data, and draw conclusions. At the elementary, secondary, and early college levels, Integrated Science practical work frequently consists of what is generally described as "cook-book" exercises (Shakhashiri, 2009).

Reports of the Board of Directors of the National Science Teachers Association (NSTA) in the USA (Abimbola, 1994) recognised that there were widespread doubts about the importance of science practical work in science teaching and learning in the seventies. For example, the national science education standard and other science education literature emphasise the importance of rethinking the role and practice of practical work in Integrated Science and science teaching in general (Hofstein, 2004). Likewise, the Ministry of Education in Singapore was examining the role that science practical work played in science education and re-evaluating how school science practical work could be made more meaningful and productive for students (Ling & Towndrow, 2010). It is due to such concerns that this study is seeking to find out the effectiveness of practical work in Integrated Science learning with a view of making it more productive and meaningful for learners in the Ghanaian context.

Teaching and learning of Integrated Science can also be supported and improved through use of information and communication technology (ICT). ICT is considered as a versatile source of scientific data, theoretical information and offers a viable means to support authentic learning in Integrated Science (Awad, 2014). Prior to Internet being available, the only learning materials were textbooks, Integrated Science laboratory facilities and equipment, and the only authority figures were teachers. However, (Awad, 2014) reports that there are so many learning materials such as html documents, *e-books* and electronic encyclopaedias in the Internet and also many ways to get in touch with authority figures such as scientists and other school teachers. All what a student may want to know can be obtained through searching the Internet.

One of the ICT opportunities in teaching and learning Integrated Science is to help students to visualize the spatial three-dimensional (3D) elemental and molecular structures, and allows collaborative interactions between teachers and students, and among students themselves (Awad, 2014). Furthermore, these learning technologies expand the range of topics that can be taught in the classroom. The computer and its Internet access extend student-learning experiences beyond the classroom by introducing real-world issues with movies, simulations and animations. They promote contextualised understanding of scientific phenomena in real world. In his research, Kearney (2004) used computer-mediated video clips to show difficult, expensive, time consuming or dangerous demonstrations of real projectile motions. The real-life physical settings depicted in the video clips provided interesting and relevant contexts for students.

2.2 Performance in School Integrated Science

Poor performance in Integrated Science is not unique to Ghanaian secondary students only. For example, the biggest challenge facing science educators and researchers in the Caribbean is the underachievement in science subjects among the secondary school students. A review of Caribbean School Examinations Council (CSEC) results in biology, chemistry, physics and Integrated Science for ten years indicated that pass rates had fallen below 50% in these science subjects (Ogunkola & Fayombo, 2009). Similarly, international studies of educational performance revealed that USA students consistently rank near the bottom in science and mathematics (Rutherford, & Ahlgren, 1991) an indication of poor performance in these subjects. Since the 1960s, Ghana's secondary school students' Integrated Science achievement has remained low (WAEC, 2020).

The WAEC (2020) WASSCE examination provisional report indicated that there were improvements in the performance of candidates at Grades A1 to C6 in English Language and Mathematics (Core) in 2020 as compared to 2019 as English Language- 48.96% in 2019 to 57.34% in 2020 and Mathematics (Core) - 65.31% in 2019 to 65.71% in 2020. However, Integrated Science recorded a decline in the performance of candidates at Grades A1 to C6 in 2020 as compared to 2019 as follows; Integrated Science -63.17% in 2019 to 52.53% in 2020.

2.3 Nature of Integrated Science Practical Activities

Integrated Science practical works have been and are being used in Integrated Science teaching to support theoretical Integrated Science instruction. The success of any given Integrated Science practical task depends on the intended learning objectives of that task. Learning objectives of Integrated Science practical tasks can be divided into two categories, for example, categories A and B. In category A, the practical tasks should be to enable the learners to: (i) identify objects (ii) learn a fact(s) (iii) identify phenomena. In Category B, the practical tasks should be to enable learners to: (i) learn a concept (ii) learn a relationship and (iii) learn a theory/model (Millar, 2004). The science educators' criticisms on Integrated Science practical works are on tasks with objectives in category (B) and not those in category (A). Millar (2004) describes the tasks with objectives in category (A) as being effective as many other forms of instruction. The observable aspects of practical tasks are often remembered many months or even years later if the event is a striking one. For example, seeing a piece of sodium put into water or the 'pop' sound of burning hydrogen gas.

The role of Integrated Science practical work is to help students make links between two 'domains' of knowledge: the domain of objects and observable properties and events on the one hand, and the domain of ideas on the other (Millar, 2004). The learning objectives of category (B) above are more strongly involved in Integrated Science practical work than those in category (A). Students are unlikely to grasp a new scientific concept or understand a theory or model (category B objectives) as a result of any single Integrated Science practical task, however well designed. Students acquire deeper and more extended understanding of an abstract idea or set of ideas in a gradual process, hence the need for frequent and varied practical activities.

Designing practical tasks that animate the students" thinking before they make any observations can make them more effective. One approach which has been found strikingly successful for this is the Predict – Observe – Explain (POE) task structure (Gunstone, 1991). In this approach, students are first asked to predict what they would expect to happen in a given situation and to write this down, then to carry out the task and make some observations, and finally to explain what they have observed (which may or may not be what they predicted). The POE structure makes the practical task more purposeful and to play a pivotal role in students' learning of science and eventually improve performance in the subject. Otherwise, a practical task designed to enable the students to observe an object or phenomenon can easily become rather dull and uninspiring, unless it is striking and a memorable one.

The above role of Integrated Science practical work is to help students to make links between two 'domains' of knowledge: the domain of objects and observable properties and events on the one hand, and the domain of ideas on the other is nowadays being met by using ICT in teaching and learning of Integrated Science. According to Awad (2014), there is an obvious growth in the importance of information and communication technology (ICT) in science education. ICT is being used as a tool for designing new learning environments, integrating virtual models and creating learning communities (e-learning). Awad (2014) also points out that, the e-learning being used in teaching and learning Integrated Science, includes informative material in electronic forms such as: www-pages, e-mails and discussion forums enhances the teaching and learning of Integrated Science. ICT is a versatile source of scientific data, theoretical information and offers a viable means to support authentic learning in Integrated Science. In teaching and learning of Integrated Science, ICT helps students to visualize the spatial three-dimensional (3D) elemental and molecular structures, and allows collaborative interactions between teachers and students, and among students themselves (Awad, 2014).

Schools should have many charged teaching sites about high school curricula. These sites should not only offer the video clips showing the lectures and experiments but also many referential learning materials. Internet websites provide student centred learning environments. The control over pacing of computer-based learning gives students the flexibility and time to thoroughly build their understandings of the subject at hand. For example, the use of computer program such as *e-science* helps students create more scientifically acceptable representations of molecules. According to Krajcik, Mamlok and Hug, (2000) software support complex processes that students are not capable of completing without assistance. Therefore, extensive use of learning technologies can help students to develop deep understanding of Integrated science concepts and processes by themselves and in so doing improve performance in the subject.

Practical works have crucial roles in determining different attitudes and learning styles of students and consequently different educational impacts on different individuals (Abimbola, 1994). The effect of practical work therefore influences students' performance in the Integrated Science examination.

2.4 Concept of Laboratory Practical Work

According to Millar, Le Marcechal and Tiberghien (1999) the concept of practical work embraces laboratory activities done by students including teacher's demonstrations. Meester and Kirscher (1995) and Millar (2004) on the other hand, defined laboratory practical work as any teaching and learning activity which involves at some point the students in observing or manipulating real objects and materials. SCORE (2009a) also looked at practical work in science as a hand 'hand-on learning experience which prompts thinking about the world in which we live'. Practical work in this sense includes fieldwork, laboratory works and experimental works. However, in the context of this study, classroom teaching is the focus but not fieldworks hence the wordings of 'practical work', 'laboratory work' and 'experimental work' will therefore, be used interchangeably to have similar meanings in Millar's context.

During practical works students are allowed to interact with materials/apparatus to check and/ or observe phenomena in a laboratory. Kallats (2001) sees practical works in this regard as a means to verify a science principle, or theory already known to the students; a means of determining the relationship between cause and effect and a means of obtaining and learning scientific information.

A practical activity is a didactic method for learning and practicing all the activities involved in carrying out practical inquiry relevant for one's profession. Science practical experiments do not only enhance the learning experiences but also help students achieve lifelong learning skills, including problem solving skills which are essential to practical works in scientific fields. According to Meester and Krischer (1995), the interrelationship between experiments, laboratory works and practical activities is that student experiment is a subset of laboratory works, laboratory work is in turn a set of practical activities, which in turn is a subset of the science education curriculum. This implies experiments, laboratory works and practical activities are all strategies designed and tailored to achieve aims and objectives of the Integrated Science curriculum.

A students' laboratory activities should be designed to develop 'higher' cognitive skills that underpin scientific methods of working (Woolnough, 1991). However, research studies have shown that most practical tasks in science laboratory manuals are prescriptive, providing little or no opportunities for open-ended or enquiry-based learning and that practical work can be unproductive and little learning of science goes on with students in practical classes (Berry, Mushall, Gunstone & Loughran, 1999; Harrison & Henderson, 1997).

For effective science practical works to occur, we need to consider the following: students must be provided with opportunities to manipulate apparatus and materials while working cooperatively with others in an environment in which they construct their own scientific knowledge and engage in processes of investigation enquiry (Tobin, 1990); the intended learning outcomes of carrying out practical works must be made clear in students' minds so that students will not be confused with the complexity of the practical task while carrying it out (Millar, 2004) the practical tasks should be well-designed and focus on certain and in depth topics to help students acquire and develop science concepts or frameworks of concepts (Hofstein & Lunneta, 2003); in order for learning to occur with practical work, students need to be given sufficient time to interact, reflect and discuss (Gunstone & Champagne, 1990); students should be taught how to take control of their own learning and provide opportunities for meta-cognitive activities, rather than concentrating on technical ones (Gunstone, 1991).

Karplus (1977) et *al* assert that a progression from exploratory activities to laboratory-type investigative activities is necessary for effective science learning. Based on the learning theory of Piaget, and Karplus et *al* (1977) developed a three-stage cycle of learning that optimises effective learning in science. These stages involve exploration stage which is based on students' experiences and they are challenged to make connections with their existing experiential background with the areas of study; concept introduction stage where the guides the students toward a model/theory which can be used to explain the observations made in the exploratory stage; and concept application stage where students undertake problem solving and laboratory investigation tasks, applying the knowledge in the second stage to new situations. Many teachers, however, focus only the third stage, omitting the first two stages which inevitably lead to the perception of science being too difficult by students who will eventually stay away from the subject. To encourage the development of scientific skills through organisation of Integrated Science practical activities, teachers need to focus on all the three stages stated above.

2.5 Aims and Objectives of Laboratory Practical Works at Senior High Level in Ghana

Hodson (2001) claimed that for the past 30 years the motives for laboratory practical works have remained unchanged although relative priorities may have shifted somewhat. To guide teaching and learning, it is very important for both teachers and students to be explicit about the general and specific purposes of what they are doing in the laboratory.

Explicating goals for specific students' learning outcomes should serve as a principal basis upon which teachers design, select, and use activities; the goals can also serve as the most important bases for assessment of students and of the curriculum and teaching strategies. To these ends, it is important to acquire information and insight about what is really happening when students engage in laboratory activities, that is, we need to examine what the students perceive in the light of important goals for science learning.

Chang and Lederman (1994), Wilkenson and Ward (1997) have found that often students do not have clear ideas about the general or specific purposes for their work in science laboratory activities. Other studies have shown that students often perceive that the principal purpose for a laboratory investigation is either following the instructions or getting the right answer. They perceive that manipulating equipment and measuring are goals but fail to perceive much more important conceptual or even procedural goals.

Students often fail to understand and to question the relationship between the purpose of their investigation and the design of the experiment they have conducted, they do not connect the experiment with what they have done earlier, and they seldom note the discrepancies between their own concepts, the concepts of their peers, and those of the science community (Klopfer, 1985; Eylon & Linn, 1988). To many students, 'a laboratory' means manipulating equipment but not manipulating ideas.

Mismatches often occur between teachers 'perceived goals for practical work and students' perception of such activities (Hodson, 1993, 2001; Wilkenson & Ward, 1997). Since there is evidence that goals of instruction are more likely to be achieved when students understand those goals, Wilkenson and Ward concluded that teachers should be much more attentive to helping students understand the general goals of the laboratory work. Since specific objectives are often different from one laboratory investigation to another, students should be helped to understand the purposes for each investigation in pre-laboratory session and to review those purposes in post-laboratory reporting and discussion.

Laboratory activities appear to be helpful for students rated as medium to low in achievement on pre-test measures (Boghai, 1979; Grozier, 1969). Godomsky (1971) reported that laboratory instruction increased students' problem-solving ability in the physical chemistry and that the laboratory could be a valuable instructional technique in chemistry if experiments were genuine problems without explicit directions. Thus, science laboratory practical works help students to develop the required scientific knowledge and attitude which are mostly needed in this scientific and technological world.

Additionally, by doing experiments students learn how to handle and operate apparatus. Hodson (1999) reported that practical work can teach laboratory skills. As students handle and operate apparatus their manipulative skills are developed. Comber and Keeves (1978) found, when studying science education in 19 countries, that in six countries where 10-year-old students made observations and did experiments in their schools, the level of achievement in science was higher than in schools where students did not perform these activities. This is perhaps the reason why Hodson (1993) stated that practical work can teach laboratory skills. This implies when students are allowed to perform laboratory practical activities their scientific inquiry skills are developed and this could help them in performing practical experiments on their own.

Through practical works students learn many good habits like resourcefulness, initiative, cooperation, etc.; develop 'scientific attitudes' such as open-mindedness and objectivity (Hodson, 1993). Hofstein and Lunetta (2003) and Lazarowitz and Tamir (1994) were of the view that laboratory activities have the potential to enhance constructive social relationships as well as positive attitudes and cognitive growth. The laboratory offers opportunities for productive, cooperative interactions among students and with the teacher and these have the potential to promote an especially positive learning environment. Hofstein and Lunetta (2003), Lazarowitz and Tamir (1994), and Lunetta (1998) stated that laboratory practical activities have the potential to enable collaborative social relationships as well as positive attitudes towards science and cognitive growth. The more informal atmosphere and opportunities for more interaction among students and their teachers and peers can promote positive social interactions and a healthy learning environment conductive to meaningful inquiry and collaborative learning. The laboratory offers unique opportunities for students and their teachers to engage in collaborative inquiry and to function as a classroom community of scientists. Such experiences offer students opportunities to consider how to solve problems and develop their understanding.

The importance of promoting cooperative learning in the science classroom and laboratory received substantial attention (Johnson, Johnson, Maruyama, Nelson & Skon, (1981); Johnson & Johnson, 1985; Lazarowitz & Karsenty, 1990) as a way to engage diverse students in collaborations with others in inquiry and to develop scientific skills that are characteristics of scientists.

By doing experiments, students are motivated to know more and more of science. According to McKeachie (2006) discovery-based instruction motivates and capitalizes on student curiosity, gives students greater ownership over the process of investigation, and thus result in deeper understanding. On his part Hodson (1993) said practical work can motivate pupils, by stimulating interest and enjoyment. Once students are motivated, they will have the desire to continue to experiment to validate the concepts learnt. This satisfies basic human desire of knowledge of what, how and why of things.

2.6 The Importance of Laboratory Work in Science Education

To date, many studies have been conducted on the importance of laboratory work while teaching science. Currently, science educators and teachers agree that laboratory work is indispensable to the understanding of science (Cardak et *al*., 2007; Ottander & Grelsson, 2006). The role of laboratory work in science education has been detailed by some researchers (Lazarowitz & Tamir, 1994; Lunetta, 1998). The main purpose of laboratory work in science education is to provide students with conceptual and theoretical knowledge to help them learn scientific concepts, and through scientific methods, to understand the nature of science.

Laboratory work also gives the students the opportunity to experience science by using scientific research procedures. In order to achieve meaningful learning, scientific theories and their application methods should be experienced by students.

Moreover, laboratory work should encourage the development of analytical and critical thinking skills and encourage interest in science (Ottander & Grelsson, 2006).

Teaching and learning of science have over the years tried to mimic what 'real' scientists do. The processes of science, the scientific method, the inquiry process, the content of science and the habits of scientists are all re-contextualized in the science curriculum for schools in many parts of the world (Ling & Towndrow, 2010). In mimicking the real scientist, the rationale for using Integrated Science practical work as a form of instruction is sometimes forgotten.

Some teachers and students place great emphasis on obtaining the correctness of the answers leaving the mastery of process skills to chance (Goh & Chia, 1988). In such cases, the range of investigations is narrowed and is dominated by the perceived demands of assessed coursework. However, the major barrier to improving the quality and variety of practical activity is the constraints felt by teachers in terms of two interrelated factors: time and the demands of the national assessment frameworks. This may force teachers to use demonstration experiments rather than student experiments and sometimes teachers end up in applying 'drill and practice' to train students to pass examinations (Lunetta, Hofstein & Clough, 2007).

Traditional laboratory classes normally involve students carrying out teacher-structured laboratory exercises or/and experiments, where each step of a procedure is vigilantly prescribed and students are expected to follow and adhere to the procedures precisely. This kind of laboratory activity is frequently known as a 'recipe lab' (Domin, 1999), in which little student involvement with the content is required. For such kind of activities, Johnstone. (1991) adds that students can be successful in their laboratory class even with little understanding of what they are actually doing. Nevertheless, the student may have little option but to accept this passive approach whilst, they deal with new techniques and/or equipment, particularly when the lab preparation involves no more than reading and understanding the laboratory manual. On a similar note, Johnstone (1991) commented that the laboratory is regarded as an information overload place, resulting in students with little 'brain space' to process information and consequently, they blindly and thoughtlessly follow the instructions. In addition, they seldom interpret their observations or/and the results obtained during the experiment.

There are two extreme thoughts regarding the importance of Integrated Science laboratory experiments/practical works (Achor, Kurumeh & Orokpo, 2012). The first one is that in traditional approaches, little opportunity is given to student initiatives or circumstance. In this approach, all the laboratory procedures are carefully listed in the provided manual, and frequently the student is simply asked to fill in a well-planned report template. At the end of a laboratory session, students have no real opportunity of understanding or learning the process of doing science.

The second one is that a student is given an opportunity to engage in deep learning (Gunstone & Champagne, 1990). This would provide a student an opportunity in identifying the main objectives of the work and in planning and executing it, of identifying the conceptual and practical difficulties encountered, recording and discussing the results and observations and of suggesting practical alterations and improvements (Watts, 2005). The latter, thus, could result in a significant positive impact on a students' ability to learn both the desired practical skills and also the underlying theory (Akpa, 2005). Integrated Science practical works should be conducted in such a way that they interact with ideas, as much as the phenomena themselves. It is necessary for teaching to focus upon scientific ways of talking and thinking about phenomena, rather than the phenomena themselves (Leach & Scott, 2003). Teachers can employ a wide variety of teaching strategies to engage students' minds in learning. Reports emphasise that teaching science with the help of practical work makes science to be more enjoyable and stimulating to students than teaching the same subject matter only through lecture (Hofstein, 2004). Students have a lot to benefit from science practical work which may include increasing students' interest and abilities in the subject as well as their achievement in science subjects (Pavesic, 2008).

Laboratory practical experiences instill in learners' practical skills and also illustrate the way scientist work in order to gain answers and offer insights into the physical world. Supporting this, Millar (2004) emphasised that laboratory practical works help students to make links between the domains of objects and observable properties and events, and domain of ideas.

The associated report (SCORE, 2009b) has a list of activities that could be considered to be practical work. This included core activities such as investigations, laboratory procedures and techniques, and fieldwork. These 'hand-on' activities support the development of practical skills, and help to shape students' understanding of scientific concepts and phenomena. To ensure better understanding of physics concepts and development of scientific inquiry skills, teachers must, therefore, endeavour to provide adequate learning experiences for students to interact with.

According to Gunstone (1991) using the laboratory to help students restructure their knowledge may seem reasonable but this idea is also naïve since developing scientific ideas from the practical experiences is a very complex process. This is perhaps one of the reasons why Gunstone and Champagne (1990) had suggested that students should be given sufficient time and opportunities interaction and reflection. On their part, Gunstone and Champagne (1990) stated that students generally did not have time or opportunity to interact and reflect on central ideas in the laboratory since they are usually involved in technical activities with few opportunities to express their interpretation and beliefs about the meaning of their inquiry. Vilaythong and Popov (2008) also argued that, practical activities enhance understanding of science theory and phenomena. Oyewola (1972) on the other hand said that, laboratory work formed an essential feature of any science course, and enables the students to understand the theory of physical laws, concepts and hypotheses.

The National Science Education Standards in the United States and other contemporary education literature continue to suggest that school science laboratories have the potential to be an important medium for introducing students to central conceptual and procedural knowledge and skills in science (Bybee, 2000). In support of this argument, Hofstein and Lunetta (2003) stated that for more than a century, laboratory works/activities have played a central and distinctive role in physics education, suggesting long recognition of importance role played by laboratory practical activities in the teaching and learning process of physics. Hodson (1993) also emphasised that the principal focus of laboratory activities should not be limited to learning specific scientific methods or particular laboratory techniques; instead, students in the laboratory should use the methods and procedures of science to investigate phenomena, solve problems, and pursue inquiry and interests. Baird (1990) is, perhaps one of several persons who has observed that the laboratory learning environment warrants a radical shift from teacher-directed learning to 'purpose-inquiry' that is more student-directed.

Others advocates of the benefits of laboratory practical works in science teaching and learning included Escobar, Hickman, Morse, and Preece (1992) who stated that the laboratory plays a central role in high school science courses in providing experiences where testing will promote development of systematic reasoning and predictive ability in students. Bruner (1961), Gagne (1963), and Schwab (1992) all extolled the virtues of teaching science as a process of inquiry or discovery. This also emphasised the importance of practical activities in science teaching-learning process.

Laboratories are, however, expensive in terms of resources and working time. Hanif, Sneddon, Ahmadi and Reid (2009) reported that declining resources at the threaten to reduce the extent of experimental work in science courses in the future. This assertion equally influenced the effective organisation of science laboratory practical activities at pre-tertiary level.

In Shulman and Tamir (1973) review of research on science teaching, identified three rationales generally advanced by those that supported the use of the laboratory in science teaching. The rationales included: The subject matter of science for that matter physics is highly complex and abstract; Students need to participate in enquiry to appreciate the spirit and methods of science; and Practical work is intrinsically interesting to students.

Contrary to these, Hodson (1993) for instance, wrote that; 'As practiced in many schools, practical work is ill-conceived, confused and unproductive'. He argued that 'for many children, what goes on in the laboratory contributes little to their learning of science'. He added, 'the root of the problem is the unthinking use of laboratory work'. Woolnough and Allsop (1985) and Osborne (1993) also expressed similar doubts about the contribution of practical work to students' science learning. Supporting the argument Hodson (1999) claimed that practical laboratory activities are unproductive, and confusing, it is very often used without any clearly thought-out purpose. He therefore, called for more emphasis on what students are actually doing in the laboratory. On his part Saunders (1992) was of the view that not all laboratory activities are equally effective in bringing about meaningful learning.

Refuting these sentiments, Sadeh and Zion (2009) stated that the goal of inquiry learning is to improve critical thinking. Tobin (1990) on the other hand, wrote that laboratory activities appeal as a way to learn with understanding and, at the same time, engage in a process of constructing knowledge by doing science'. He further stated that meaningful learning is possible if students are given opportunities to manipulate equipment and materials in order to be able to construct their knowledge of phenomena and related scientific concepts.

Laboratory work is often used in teaching natural science, especially a broad spectrum of Biological Science (Hughes & Overton, 2008). During the last 20 to 30 years, there has been a renewed of interest in learning by enquiry and in the use of laboratory work in demonstrating biological principles (Headelsman, 2004). Laboratory work is the hall mark of education in science and technology-based fields. Practical work is a central theme of lesson in the natural science (Galton & Eggleston, 1979; Hofstein & Lunetta, 2003).

Laboratory work is seen as an integral of part of most science courses and offers students a learning environment that differs in many ways from the traditional classroom setting. It is important to consider whether learning is more effective, if the student do the student experiments themselves or they watch the teacher demonstrate the student experiments. Are either of these approaches more effective than the teacher simply describing the student experiments to the students and telling them the results (Killemann, 1998). It is hard to image learning about science without doing laboratory or field work. Student experimentation underlies all scientific knowledge and understanding. It provides students with opportunities to think about, discuss and solve real problems. No science can be taught properly without student experiments. The students' experiment should be the central part of science teaching. The students' experiments are performed to find relation amount concepts, as in other science lessons, the effectiveness is related to the use of teaching methods (Killemann, 1998).

Laboratory work can create an environment that encourages students to question thereby fostering critical thinking Students are often encouraged to work in small groups, leading to social interaction and peer teaching. In addition, students will gain technical skills and are often offered success to modern technology. There are however, possible pitfalls to this method of teaching. For example, the teacher or student may place too much focus on technology, without time to interact or reflect on central ideas, thereby missing learning goals (Gunstone, 1991).

2.7 The Frequency of Integrated Science Practical Activities and Students' Performance

One of the biggest ways that practical activities have been shown to impact students have been in regard to students' performance on standardised examinations. Engagement in frequent practical activities during an urban reform program in Detroit Public Schools demonstrated that a practical activity science curriculum can lead to standardised achievement test gains in historically underserved urban students (Geier, 2007). Stohr-Hunt (2019) affirmed that data from the National Education Longitudinal study indicated that students who engaged in hands on activities every day or once a week scored significantly higher on a standardized test of science achievement than the students who engaged in hands on activities once a month, less than a month or never. In Iran, a study by Abdi (2014) also reveals that practical activity-based learning produced higher scores than traditional teaching methods. Research by Lee (2011) has shown that students were taught with a frequent practical activity approach outperformed the students in traditional lecture instructional method in science problem solving. Similarly, the findings of Olorukooba (2002) revealed that female students achieved higher results in frequent practical activities lessons than that of theoretical learning lessons.

Research study carried out by Effandi (2003) focused on how a frequent practical work affects students' performance and problem-solving skills in science. This study showed significantly better results in science performance and problem-solving skills. This suggests that a frequent practical activity can enhance scientific skills, promote inquiry learning and increase science performance among students. This therefore requires that students should be adequately taught through practical activities to acquire useful practical skills in science concepts.

Reports from the Chief Examiner of the West African Examinations Council (2015-2019) confirmed that many students have poor knowledge in basic concepts in Integrated Science. The examiners attributed this problem to the theoretical nature in which science teachers teach their students without involving them in regular practical activities. They are of the view that the use of regular activity tuition such as hands on activities, practical approach and deductions to get the conclusion as well as more student-student, and teacher-student interactions in the teaching and learning process will help improve students' performance in science. Science teachers must therefore engage students in regular practical activities to ensure that they have equal opportunities to learn.

Report from the Chief Examiner of the West African Examinations' Council (2020) also confirmed that most of the candidates performed poorly in both theory and test of practical work in Integrated Science.

The examiners observed that most candidates:

- Failed to record length measured with the metre rule to one decimal place in centimetres;
- Were unable to plot points correctly to the accuracy of chosen scales;
- Were unable to make simple deductions from the graphs;
- Had difficulty in identification of colours of precipitates, residues and solutions.

The Chief Examiners for the science subjects generally recommended that candidates should be taken through many practical lessons to improve their performance. The Chief Examiner's report of Integrated Science also suggested remedies by which candidates' weakness may be corrected. The suggested remedies are:

1. Candidates should be helped to identify and understand the scientific principles underlying everyday occurrence;
2. Teachers should allot more time to take the students through practical exercises and usual laboratory activities;
3. Teachers should demonstrate the procedure used in practical activities;
4. Teachers should give more exercises in organic chemistry especially drawing of structures;
5. Teachers should help students to master biological drawings;
6. Teachers should do their best to explain the theories and principles in physics and their applications to students;
7. Students should be encouraged to practice more questions on practical work.

The report attests that most teachers do not read the Chief Examiners report, otherwise they would have made changes in their teaching to help students overcome their weakness in the answering of some theory and practical questions.

Granstorm (2005) showed that different teaching approaches in the classroom influence students' outcomes in different ways. In classroom settings where students are allowed and encouraged to co-operate with their classmates, teachers give the students more opportunities to understand and succeed. With the advent of the concept of discovery learning, many scholars today widely adopt suppler student centred methods to enhance active learning (Greitzer, 2002). Most science teachers today apply student-centered approach to promote interest, analytical research, critical thinking and enhancement of students' performance in science (Hesson & Shad, 2007). In order to develop students' interest in the subject, Tufour (2007) maintains that the teaching of the subject should provide opportunities for students from seeing science as a school activity, to understanding the nature and technological activity beyond the classroom experience. Therefore, there is the need for science teachers to adopt a frequent practical activity approach to assist students in their academic activities, stimulate and sustain their interest in science performance.

2.8 Gender and Performance in Integrated Science

Gender and its manifestation in various human activities appear to be a strong predictor of human conduct. In education, many differences have been documented between achievements of males and females. Many researchers and educationalists feel that gender difference is one of the factors that affect academic performance (Sempala, 2005). Gender has a crucial role in determining different attitudes and learning styles and consequently different impacts of educational activities on different individuals. The sex role stereo type students are attached to could influence how they perform in both practical and theoretical aspects of Integrated Science examination (Akpa, 2005). The biased way in which science is presented at school and portrayed by media continues to feed usual gender stereotypes. Gender differences in competence beliefs concerning science are reported as early as kindergarten level (Cuomo, Serpico & Balzano, 2007).

Science learning is a typical gender role–stereotyped domain in which boys and girls tend to be strongly conditioned by the self-perception of their competences and skills.

This may result in resistances and lack of self-confidence (typical in girls) or in overestimation and excess of desire to be in the limelight (typical in boys) (Cuomo, et al, 2007), which has strong impacts on academic performance. For example, although the performance in science subjects at all levels of the Uganda education system is poor; the performance of girls is always poorer than that of boys (Kakinda, 2007). Other observations by the Permanent European resource Centre for Informal Learning (PENCIL) pilot projects (Cuomo, et *al*., 2007) showed that educational programmes can be designed which are attractive for both girls and boys, leading to success in science learning. Therefore, gender is an important factor that contributes to performance in Integrated Science.

Studies by (Okeke, 1990) clearly indicate the state of affairs at the secondary level of education in Nigeria which shows that a greater proportion of males enrolled and achieved higher than their female counterparts. Their study also showed that at all levels of education in Nigeria, females were grossly underrepresented in terms of enrolment, participation and achievement in science, technology and Mathematics education. Elsewhere observations on the disparity in male-female performance in sciences exist (Sempala, 2005; Hodson, 1993). Studies carried out by Bell (2001) and Burns (1987) in UK and New Zealand respectively, also showed that male students outperformed their female counterparts in the physical sciences. The report of similar study conducted by Anderson (1987) indicated that in America, there were too few women in the sciences and related professions like Engineering and Technology.

Okeke (1990), reported that boys perform better than girls on physical science questions and high-level questions (application, analysis and synthesis) whereas girls do as well as, or better than boys on questions in biological sciences and lower level (knowledge, recall and comprehension) questions. Research study carried out by Mari (2001) focused mostly on the effect of gender factors on students' under-standing of science process skills in science learning among junior secondary schools' students. The results showed that male students were significantly better in their understanding of science process skills than their female counterparts and that there was significant difference between the male and female students in their ability to solve problems requiring their understanding of the process skills. Process skills are developed through doing Integrated Science practical work.

There are also numerous quantitative studies on the academic achievement of males and females in different subjects. In academic achievement, many studies investigated the academic gender gaps, most found that males outperformed female counterparts in science, and the gaps are larger than mathematics. It has been reported that males are significantly better than females in biology, introduction to science, and physics (Becker, 1989; Steinkamp & Maehr, 1984). Cleary (1991) found that males outperformed females on science tests across all age groups and this advantage increased with age. A meta-analysis revealed a male advantage on science tests ranging from 0.11 to 0.50 standard deviations (Hedges & Nowell, 1995).

2.9 Scientific Inquiry Skills to be Developed for Practical Works

It is very important to understand the skills referred to as scientific skills as used in their study. Learning by inquiry is posing challenges for teachers and learners (Krajcik, Mamlok & Hug, 2001). In a broader sense, inquiry refers to diverse ways in which scientists study the natural world, propose ideas and explain and justify assertions based upon evidence derived from scientific work. It also refers to more authentic ways in which learners can investigate the natural world, propose ideas and explain and justify assertions based upon evidence and in the process sense the sense the spirit of science.

The Integrated Science teaching syllabus (2010) specifies experimental and process skills to be assessed by providing generic mark schemes for the practical papers. This pre-supposed that students need to acquire certain skills before they could respond effectively to the tasks contained in the test items of the practical examination papers. The marking schemes divide the experimental and process skills to be acquired into four broad areas and these include manipulation of equipment/apparatus, measurement and observation, presentation of data and observations; analysis, conclusion and evaluation; and planning.

Students have to master the basic skills of manipulating apparatus, making measurements, displaying their data in tables and on graphs, and drawing conclusions. They also have to learn to critically evaluate the experimental procedures by identifying limitations and sources of errors and by suggesting improvements. These skills can only be developed when students are allowed to a greater degree of control over the procedures, they use in laboratory practical classes.

2.10 Aims of Science Resource Centre Manual (SRCM) (2013)

This manual has been written to support the teaching of enquiry-based experimental science. It comprises a series of practical experiments to support the delivery of West Africa syllabuses in Biology, Chemistry and Physics. Each practical has at least one aim. The practical works are designed to teach students the following;

1. How to develop manipulative and technical skills
2. how to use scientific apparatus safely, carefully and properly

3. the use and relevance of a variety of scientific techniques
4. how to plan, carry out and record experiments and investigations
5. how to analyse, conclude and evaluate data
6. how to apply previously learnt knowledge into a new or practical situation

Each practical state which skills are developed while it is being undertaken. The tables below show the various skills set.

Table 2.1: How to Teach Practical Work: 10 key points (SRCM, 2013)

	What to do	How to do it	Examples
1	Decide on the skills and processes you want the students to learn	See sheet 'Scientific Skills and Processes'	How to use a thermometer
2	Decide on the best method of delivering the Practical	See sheet 'Methods of delivering Practical Sessions'	Whole class
3	Decide on the most suitable type of practical activity	See sheet 'Types of Practical Activity'	Skill development, following instructions
4	Be organised well in advance	Write out your plans, including timings Tell your technician what to prepare	Growing seeds, pot plants Preparing solutions
5	Consider Health and Safety issues	Warn students about hazards Remind students about lab rules	Take care with razor blades No running in the lab
6	Make sure your students know what skills and processes they are learning	Tell students clearly, orally and in writing, what they are going to do, draw attention at the end to what they have learned	'Today we will be learning how to record results'
7	Teach students to be inquisitive	Ask students lots of questions (rather than giving them answers first) Encourage and expect students to ask questions and offer their own ideas	'How do you think we could record our results?'
8	Teach students to be careful and honest in measuring and recording exactly what they find	Plan exercises where students and teachers crosscheck recordings, including correct use of units	Prepare a measurement circus
9	Teach students to follow instructions and to preserve	Plan simple exercises where students in pairs crosscheck each other to see if instructions followed and feedback to teacher	Making a temporary slide Wiring a plug
10	Teach students to be methodical	Tell them to collect all equipment before starting; prepare results table first; allow time for washing up and tidying away	Wiring a circuit

Table 2.2: Scientific Skills and Processes (Scientific Inquiry Skills) (SRCM, 2013)

Skills/process	Explanation/Implication	Examples
SIS 1	**Make observations, raise questions and formulate hypotheses**	
Observing	Being accurate, consistent and specific; comparing and contrasting; classifying	Behaviour of snails; Classifying metals/non metals Bulbs in a circuit
Measuring	With accuracy and precision, using appropriate instruments correctly	Thermometer Measuring cylinder Ammeter
Manipulating	Using and looking after equipment correctly with care, accuracy and safely	A microscope An electrical balance A power pack
Following instructions	Being persistent, accurate and careful	Setting up a photometer Making solutions Setting up a circuit
SIS 2	**Design and conduct investigations**	
Hypothecating	Predicting, explaining, using Null based on personal observation, own knowledge and understanding and scientific literature. Examining credibility of scientific claims	Enzyme action is affected by temperature Copper is denser than lead A black can cools down quicker than a silver one
Identifying and eliminating variables	Identifying dependent and independent variables, constructing a 'fair test' where all factors (variables) are kept the same except the one being investigated	Vary the temperature, all else kept the same Use same volumes of copper and lead Equal amounts of water at same temperature
Planning	Designing a clear procedure, selecting apparatus, deciding range, units and explaining the purpose of the practical	Decide concentration of enzyme and substrate Use measuring cylinder of correct size Use temperature sensor to record changes over time
Recording	Deciding method, using diagrams, pie charts, tally charts, use and construction of tables, understanding reliability	Tally chart for ranges of leaf size Table recording rates of a reaction Diagram of field lines

SIS 3	**Analyse and interpret results of scientific investigations**	
Graphs	Bar charts, histograms, line graphs, best fit, error bars and when to use which, including the use of ICT for plotting	Histogram for ranges of leaf size Line graph for rate of reaction against concentration Bar charts for thermal conductivity of metals
Analysing	Interpreting and explaining trends, patterns and relationships, anomalous results; statistics	Look at shape of Histogram Establish relationships from line graph Rank metals by conductivity
Concluding	Describing and explaining results; applying K&U, referring back to original hypothesis	Conclude extent of leaf size Conclude nature of relationship Conclude range of conductivities
Evaluating	Gauging worth of both method and results; making suggestions for improvements and further investigations	Size of sample adequate? Range of concentration adequate? Was measuring sufficiently precise?
SIS 4	**Communicate and apply the results of scientific investigation**	
Explaining	Describe and explain scientific concepts, tables, graphs, statistical analysis	
Arguing	Construct a reasoned argument and respond to criticism	
Communicating	Use appropriate language and vocabulary, use and refine models	

Table 2.3: Methods of Delivering Practical Sessions (SRCM, 2013)

	Type of practical activity	Definition	When/Why	Example
1	Demonstration	Teacher demonstrates a technique or higher order skill	When safety is an issue, when too dangerous for pupils to attempt When new skills are being shown	Potassium on water Dissection technique
2	Whole-class practical	Each pupil or small group (2- 4) does the same activity	When equipment and safety are an issue; where pupils develop their own skills and generate their own data set (results)	Exploring Hooke's Law
3	Shared whole-class	As above, but pupils or groups do different aspects of an activity	As above but pupils contribute to a class set of data for more conclusive analysis. Fosters team working skills	Exploring Hooke's Law with different spring
4	Circus	As above, but pupils or groups move from one activity to another during the lesson	When there is a shortage of equipment. When a range of short activities is to be done. When methods can be compared	Exploring human psychology; comparing types of blood pressure/ heart rate monitor
5	Split practical works	Practical work carries out over two or more sessions	When there is a shortage of equipment, when classes are too large to accommodate safety or in the space available	Using burettes during titrations
6	Traditional versus electronic	Pupils use non-electronic techniques as well as ICT to generate and analyse results	When there is a need to use, compare and evaluate the efficiency of the method and quality of the data obtained	Using dataloggers; thermometers and temperature sensors

The aim of the manual is to move students on and away from rote learning and following instructions into questioning, designing, planning, carry out, recording, analysing and evaluating results.

2.11 Theoretical Framework

The study was guided by the constructivist leaning theory as postulated by John Dewey who noted that humans generate knowledge and meaning from their experiences (Dewey, 1978; Bruner, 1960). The theory describes learning as an active, internal process of constructing new understandings. It says that people construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences. The learner must play an active role in taking on new knowledge (Millar, 2004). He or she has to make sense of the experiences and discourse of the Integrated Science class and use it to construct meaning. This is the constructivist view of learning.

The constructivist model suggests that learners construct their ideas and understanding on the basis of series of personal experiences (Bruner, 1960). Learning science at school level is not discovery or construction of ideas that are new and unknown to learners rather it is making what others already know your own (Millar, 2004). Experiences given during Integrated Science practical work can provide such opportunities for Integrated Science students. For example, Barton (2004) suggests that, after an illustrative Integrated Science practical work, students are offered explanations, models and analogies from the teacher to help them in their efforts to construct their own understanding of what they have experienced. The primary criterion which a practical activity should satisfy is that of being an effective means of communicating the ideas it is intended to convey. This study is asking how this happens in school Integrated Science practical work and how effectively this augment other forms of communication (verbal, pictorial, symbolic) that teachers might use. According to Hofstein and Lunetta (2003), a constructivist model currently serves as a theoretical organiser for many science educators who are trying to understand cognition in science.

According to Miha (2006), constructivism provides a perspective on teaching and learning science in classrooms, with a view to improving the effectiveness of science teaching in enhancing students' learning. Solomon (1987) argues that, according to constructivism the most important thing in science teaching and learning is providing students with learning environment that promotes their understanding of science by co-constructing and negotiating ideas through meaningful peer and teacher interactions. This study identifies nature, and frequency of Integrated Science practical works as major parts of learning environment which influence construction of Integrated Science knowledge in Senior High School students. The core view of constructivists on learning science suggests that students construct their knowledge strongly influenced by social environments, such as whether the school is single gender or mixed gender in nature. Therefore, constructivists acknowledge social dimension of learning such as the classroom and learning community whereby students make meaning of the world through both personal and social processes (Driver et *al*, 1994; Kearney, 2004).

According to Miha (2006), the emphasis of learning activities means two things: student-centred teaching and laboratory –centred teaching. The centre of instructional activities are the students themselves, so teacher-centred teaching does little good in students' learning processes. Activities such as performance of experiments (class experiments) and discussion about the results with peers can help students to build understandings. The nature, and frequency of the laboratory–centred teaching (Integrated Science practical work) is crucial in constructing new knowledge and concepts by students. During these laboratory activities, students have opportunities to learn the procedure and skills that are facilitating conceptual changes that may lead to increase performance in Integrated Science.

Constructivism transforms the student from a passive recipient of information to an active participant in the learning process. Research indicates that student achievement and motivation for the study of science improves dramatically if students are active participants in constructing their own knowledge and in learning to use that knowledge to analyse scientific processes (Khan, Hussain, Ali, Majoka & Ramzan, 2011). Meaningful learning in the laboratory would occur if students were given sufficient time and opportunities for interaction and reflection. Also, Tobin (1990) and Ikeobi (2004), report that meaningful learning is possible from a given laboratory experiments if the students are given ample opportunities to operate equipment and materials that help them to construct their knowledge of phenomena and related scientific concepts. The construction of deep scientific knowledge results from actively practicing science in structured learning environments, that is, where the nature and quality of laboratory activities are taken into consideration.

2.12 Summary of the Literature Reviewed

The literature review highlights the need to investigate the effect of Integrated science practical work on performance in Integrated Science in order to establish the effectiveness of Integrated science practical work as a teaching and learning strategy in secondary school Integrated science. Practical work is a characteristic feature of science teaching at all levels of education. However, Abrahams and Millar (2008), report that, questions have been raised by some science educators about the effectiveness of science practical as a teaching and learning strategy. This brought out a need for a study to find out the effectiveness of Integrated Science practical and to establish whether the use of Integrated Science practical work as a teaching learning strategy had an effect on performance of Integrated Science at secondary school level.

This chapter has included literature review on: Senior High school Integrated Science instruction, performance in Senior High School Integrated Science, nature of school Integrated science practical activities, aims and objectives of laboratory practical works, at Senior High School, importance of laboratory works in science education, frequency of Integrated Science practical activities and students' performances, gender, scientific inquiry skills to be developed for practical work, aims of science resource centre manual, and theoretical framework. From the review, Abrahams and Millar (2008) report that they were unaware of any systematic study that compared the amount or type of science practical work used in schools to performance in science, although, it is widely recognised that more practical work is carried out in school science teaching in the UK than in most other countries.

Dillon (2008) points out that there have been concerns about practical work in schools' science where the range of investigations are cited as narrow and dominated by the perceived demands of assessment at the end of the three-year course. He also pointed out that the concerns were echoed by sections of the science community, industry and business, and teachers themselves who argued that schools in general are not doing enough practical work, both in and out of the classroom, and that its quality was uneven. Leach and Scott (2003), points out that many students tend to shy away from science and so to attract students to science, creative methods for teaching and learning should be developed for all levels, from primary school to university. All these concerns indicate a need to find out the role and effect of practical work in science learning.

Abrahams and Millar (2008) point out that many within the science education community and beyond see science practical carried out by students as an essential feature of science education. Hofstein (2004) reports that, teaching science with the help of practical work makes it more enjoyable and stimulating to students than when teaching the same subject matter only through lecture. Students have a lot benefits from science practical work which may include increasing students' interest and abilities in the subject as well as their achievement in science (Pavesic, 2008). Despite all these, Wellington (1998) commented that "teachers are always surprised, even shocked, when asked to consider what practical work in science is for". Dillon (2008) adds that there are nagging questions regarding the effectiveness of science practical work as a pedagogical tool.

Report by Hofstein (2004) shows that, research has failed to show a simplistic relationship between experiences provided to the students in the laboratory and learning science. Likewise, Barton (2004) reports that literature on practical work in school science, indicates that there is no clear consensus about the relative merits of these science practical works and why we devote so much of our time and limited resources to it. Abimbola (1994) shows that reviews of research carried out in this area conclude that science education researchers have failed to provide conclusive evidence to support the view that using practical work as a method of teaching science is superior to other methods, at least, as measured by paper and pencil achievement tests.

Millar (2004) states that, the role of science practical work is to help students make links between two 'domains' of knowledge: the domain of objects and observable properties and events on the one hand, and the domain of ideas on the other. This same role is nowadays being met by using ICT in teaching and learning of Integrated Science. According to Awad (2014), there is an obvious growth in the importance of information and communication technology (ICT) in science education. ICT is a tool for designing new learning environments, integrating virtual models and creating learning communities (e-learning). The e-learning being used in teaching and learning Integrated Science, including informative material in electronic forms such as: www-pages, e-mails and discussion forums enhance teaching and learning of Integrated Science.

The literature review shows that the study was guided by the constructivist leaning theory as postulated by John Dewey who noted that humans generate knowledge and meaning from their experiences (Dewey, 1978; Bruner, 1960). The constructivist model suggests that learners construct their ideas and understanding on the basis of series of personal experiences (Barton, 2004). Personal experiences given during Integrated Science practical work can provide such opportunities for Integrated Science students. According to Miha (2006), constructivism provides a perspective on teaching and learning science in classrooms, with a view to improving the effectiveness of science teaching in enhancing students' learning. Also, as stated by Tobin (1990) and Ikeobi (2004), meaningful learning is possible from given laboratory experiments if the students are given ample opportunities to operate equipment and materials that help them to construct their knowledge of phenomena and related scientific concepts and improve performance in the subject.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Overview

This chapter deals with the description of the methods and procedures that are used in carrying out this research study. The description is organised into the following sections: research design, population, sample size and sampling techniques, research instruments, data collection procedures, data analysis and ethical considerations.

3.1 Study Area

There are sixteen (16) Administrative Regions in Ghana. The study was carried out in the Wa Municipality which is the capital town of the Upper West Region of Ghana. It is one of the less densely populated regions in the country. The researcher chooses this area because of its proximity, the limited nature of time for the programme and the availability of the respondents. This research is targeted at the second year (SHS 2) Integrated Science students of Islamic Senior High School, Wa. The school is about 12 kilometers from the town's lorry station, which is located at the south-eastern part of the Wa Township, along the Busa road. The school is among the only five public senior high schools in the Municipality. The Municipality has a population of about 127, 284 people and it lies between Latitudes 9º40'N to 10º20'N and between Longitudes 9º40'W and 10º15'W. It also has an area of approximately 234,740 km^2, about 6.4% of the area of the region.

3.2 Research Design

This comprises the steps used to collect data for the study. Research questions were formulated and an action research design was subsequently used in answering the research questions. According to Johnson and Christensen (2008) research design is the plan or strategy the researcher used to investigate the research question(s). The design of a study gives a picture of events and assists in explaining people's opinion and behaviour on the basis of data gathered at a point in time (Polit & Hungler, 1995). This study employed action research designed to investigate the effect of practical activities on students' academic achievement in some selected topics in Integrated Science. It was also structured to gather pre-intervention and post intervention test results to analyse effect of practical activities on SHS 2 students' performance in Integrated Science at Wa Islamic SHS. Action research was chosen because it would improve teacher's classroom practices; enhances students' learning and also promotes personal and professional growth of the teacher (Johnson & Johnson, 1995). This study was carried out in three phases.

The first phase consisted of pre-intervention exercise which included review of basic laboratory skills learnt in the previous semesters with students followed by pre-testing students' levels of acquisition of the basic skills. Phase two was the implementation of the intervention strategy. Under this, the researcher developed lesson plans incorporated with practical activities and used them to Integrated Science laboratory practical lessons for four weeks. During the intervention exercises, the researcher used classroom observation schedule to assess the laboratory practical skills which were developed by students. Post-intervention exercise was then administered to enable the researcher assess the effect of the intervention strategy on students' academic achievement on the selected topics in Integrated Science.

The Pre-test and the post-test designs and observation schedule were used to determine the performance of the students before, during and after treatment. Students

Achievement Test (SAT) was used to test students' performance in Integrated Science.

3.3 Population

Population refers to the entire set of individuals or elements that meet the sampling criteria (Creswell, 2003). A research population is also known as a well-defined collection of individuals or objects known to have similar characteristics. All individuals or objects within a certain population usually have a common, binding characteristic or trait.

The target population for the study consisted of all students of Wa Islamic Senior High School. The accessible population for the study was the SHS 2 Integrated Science students of the 2020/2021 academic year of the school. The school has a population of about 2,450 students. The school runs programmes in General Arts, Home Economics, Business and General Science.

3.4 Sample and Sampling Techniques

A sample is any part of a population of individuals on whom information is obtained (Fraenel & Wallen, 2009). In most cases, a sample is selected because it is impossible, inconvenient, and uneconomical to screen the entire population for a study.

The sample comprised 50 students who were in the form two class (25 students per gender). The sample of the 50 students was selected from form two Integrated Science class. The selection of the sample for the study adopted purposive technique. In this type of sampling, the sample is hand-picked for the research (Awanta & Aseidu-Addo, 2008). Purposive sampling was used because the researcher has knowledge about the target group.

Table 3.1: Research Sample Distribution for the Study

Form/Class	Boys	Girls	Total
SHS 2	25	25	50

The designed sample of 50 students was distributed as showed in Table 3.1. Table 3.1 shows 25 boys and 25 girls which are formed the intact class for this study.

3.5 Research Instrumentation

This refers to the various techniques employed by the researcher to collect the necessary data for the study. This study used both qualitative and quantitative data gathering instruments.

The data for this study was collected using student achievement tests (SAT) through the pre-test and post test results and observation schedule.

3.5.1 Student Achievement Test (S AT)

Student academic achievement in the study was evaluated using the researcher created Integrated Science Student Achievement Tests (SAT). Two student achievement tests; a pre-test and a post-test, were constructed and used by the researcher. Instructional package (Lesson notes on practical activities) was used to teach the intact class. Two sets of lesson plans for teaching of the four selected Integrated Science topics for the study were prepared by the researcher using the scheme of work (Appendix 6). The practical test items were used as instruments for data collection in the study. The test collection was into two folds; pre-intervention and post-intervention tests. The test comprised 4 practical test items on Integrated Science for both the pre-intervention and post-intervention (Appendices 2 and 3). The respondents answered the practical test items in duration of 60 minutes (1 hour). All the questions carry equal marks, that is, 5 marks each making a total of 20 marks for each intervention. According to Kumar (2005), pre-test and post-test designs are the most appropriate design for measuring the impact or effectiveness of a program. The post-test items were similar to the pre-test items and therefore can be said to be of the same difficulty indices. This helped in the analysis of both stages of intervention of the study in order to make a comparison between each item.

3.5.2 Observation Schedule

This is primary technique of collecting data on non-verbal behaviour of participants and involves getting to the field (participants or institutions) to collect data based on their behaviour. In this study, participant observation which involves the researcher taking on insider role in the group being studied and does not declare that he is a researcher (Cohen, Manion & Marrison, 2007). The researcher used this observation schedule to collect supplementary data on students' acquisition of inquiry skills on their ability to perform laboratory practical activities on their own during intervention exercises. The instrument was made up of two sections, A-B. Section A contained four items on the general information of the classroom. Section B had five items on the acquisition of inquiry skills to be developed by the Integrated Science Students during practical work lessons (Appendices 7,8, 9, and 10).

3.6 Validity of the Research Instrument

Validity of the research instrument is the ability of an instrument to measure what is intended or designed to measure. According to Kumar (2005), the judgment that an instrument is measuring what it is supposed to is primarily based on the logical link between the questions and objectiveness of the study. In order to ensure the validity of the instruments, the researcher used his supervisor, departmental head of science and other science teachers, to scrutinize and ascertain the face and content validity of items of the instruments. The supervisor, departmental head and other science teachers also assessed the relevance of the content that were used in the research instrument and the necessary modifications were made based on their feedback.

3.7 Reliability of the Research Instrument

Reliability is the degree of accuracy or precision in the measurement made by the research instrument (Kumar, 2005). Therefore, a measuring instrument is reliable if it provides consistent results (Kothari, 2004). To determine the reliability of the research instrument, the researcher used the test-retest method. According to Troachim (2002), the test-retest reliability is estimated by administering the same test to same sample on two different occasions. The reliability coefficient of 0.82 was determined by using the Pearson product-moment correlation coefficient formula for the students' responses on SAT.

3.8 Time Schedule

Prior to the actual treatment with the intact class, strategies were put in place for effective implementation and supervision of the whole study. The instructional time-table used in the school indicates that three periods are allocated for Integrated Science lessons in a week; each period is one hour duration.

The data collection of the study was designed for seven (7) weeks. The first week (3^{rd}-7^{th} May, 2021) was used to revise some of the basic laboratory practical skills learnt in the previous semesters. The second week (10^{th}- 14^{th} May, 2021) was also used to administer and score the pre-test to the students. The teaching took place for four weeks (17th May to 7th June, 2021). After the four weeks of teaching, the researcher administered the post-test to the intact class the seventh week (14th June, 2021).

3.9 Data Collection Procedure

The data collection was done by the researcher. The sample lesson plans, schemes of work and classroom observation schedules were used by the researcher during the period of the study. All the SHS 2 Integrated Science intact class students selected in the school were involved in the research process throughout.

The data collection procedure was divided into three stages: Pre-intervention, intervention and post-intervention. This study lasted a period of seven (7) weeks.

3.9.1 Pre-intervention

This stage comprised two activities which were carried out to ascertain students' level of acquisition of the basic laboratory practical skills and determine their entry points with respect to the topics to be treated. The first activity was the revision of some of the basic laboratory practical skills learnt in the previous semesters. These included setting up of apparatus/equipment, measurement of physical quantities, and observation of results in tabular forms. This revision activity took place in the first week of the study. Immediately after the revision of the basic laboratory practical skills, the students were pretested to determine their entry points with respect to the topics to be treated. The students' responses to the pre-test were marked and analysed. The pre-intervention data collection was organised to ascertain the students' performance in Integrated Science.

3.9.2 Intervention

The intact class of this study was taught by the researcher in four weeks. The topics for four weeks were based on the scheme of work of the study. Weekly lesson plans for teaching of four Integrated Science topics selected for the study was prepared by the researcher in line with scheme of work of the study. Each lesson plan lasted 120 minutes (a double period). The teaching-learning strategies that were employed by the researcher included class demonstration and group works. Students were guided to perform hands-on practical activities in the laboratory on their own. The lesson plans were incorporated with the laboratory practical activities to be performed for the weeks. The practical activities that were performed in each of the four weeks were focused on acquisitions of "Applying knowledge" and "Practical and Experimental Skills". At this stage, the teacher monitored and offered encouragements as the students performed the task by working in groups using the apparatus or information given to them.

The teacher highlighted the major points of the lesson on the chalkboard clarified students' misconceptions and summarised the lesson. The summary included all the undertakings in the class during the period. The teacher then selected areas of practice or assignments for the students. This was in the form of definitions, calculations on aspects relevant to the topic to be discussed during the lesson. Students' responses to these exercises were marked and the marked scripts were distributed to students before the next week's assignment. Descriptive feedbacks were provided on each wrong response provided by students. These enabled students identify specific areas that needed improvement. General discussions on the feedbacks of the assignments were done after the distribution of marked scripts to students. The researcher used classroom observation schedule to assess the laboratory practical skills which were developed by students during the practical exercises that were performed in each of the four weeks (Appendix 1).

3.9.3 Post-intervention

At the end of the intervention the students wrote a test (post-test) on the fifth week. This test purposely evaluated the performance of students after the four weeks' instruction. It was to find out the effect of practical activities on SHS 2 students' performance in Integrated Science after the intervention. The post test was made up of 4 practical test items just in the same line as the pretest. The post-test items were selected based on "Applying knowledge" and Practical and Experimental Skills as spelt out in the Integrated Science syllabus and significantly test critical thinking and understanding if the students in practical work experience in Integrated Science. The post-test items were fairly selected to cover most of the units in Integrated Science. After the post test, scripts were collected and marked using a marking scheme (Appendices 4 and 5). The scores were then presented in tables.

3.10 Data Analysis

The collected data was organised and analysed using both qualitative and quantitative methods. The data generated from the student achievement tests (SAT) were ordered, coded, categorised, classified and labelled as per themes and objectives of the study. The Microsoft Excel programme was used to analyse the data. Descriptive statistics such as frequencies, percentages, means and standard deviations were computed and the results were presented in tables and descriptive form. Inferential statistics such as dependent t-test was also employed to analyse the data.

3.11 Ethical Considerations

The researcher ensured that the respondents were not coerced into participating in the study but rather were voluntarily and willingly participated. Aside respondents' willingness to participate in the study, the researcher again, ensured that no harm was caused to any of the respondents, be it physically or psychologically. Lastly, the researcher ensured that the respondents' responses were kept confidentially.

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION OF FINDINGS

4.0 Overview

This chapter presents the results of the analysis, the interpretation and discussion of findings of the study. The purpose of the study was to investigate the effect of practical activities on SHS 2 students' performance in Integrated Science at Wa Islamic SHS in the Wa Municipality of the Upper West Region of Ghana.

This presentation of results of the study was done based on the following objectives which were to determine the effect of practical activities on SHS 2 students' performance in Integrated Science, use frequent organisation of practical activities to develop and improve upon the scientific inquiry skills of students, determine the effect of frequent of practical activities on SHS 2 students' performance in Integrated Science and determine the difference between practical activities on male and female students' performance in Integrated Science.

4.1 Data Analysis

Data analysis and results are presented based on the research questions.

4.1.1 The effect of practical activities on senior high school students' performance in Integrated Science

Research Question 1

What is the effect of practical activities on SHS 2 students' performance in Integrated science?

This question raised in this study was to find out if the use of practical activities had any effect on students' performance in the study of Integrated Science. As already indicated students were taken through revision of some basic laboratory practical skills and guided to perform hands-on practical activities in the laboratory on their own. Each lesson plan was incorporated with laboratory practical activities which focused on acquisitions of "Applying knowledge and Practical and Experimental skills". The students were given pre-test and post-test of the Student Achievement Test of Integrated Science to check the effect of each teaching strategy on students' performance. Students' scores in pre-test and post-test were used to calculate their average normalized gain in Integrated Science. Table 4.1 gives the summary of the descriptive statistics on the pre-test and post-test Analysis.

Table 4.1: Mean scores of Students' Academic test based on the Effect of Practical Activities on Students' Performance in Integrated Science (N=50 in both cases)

Form/Class		Pre-Test Scores	Post-Test Scores	Mean Gain Scores
SHS 2 Students of Intact Class	Mean	17.30	32.10	14.80
	Standard Deviation	8.65	16.34	

Table 4.1 shows that the intact class before treatment (pre-intervention) had a mean score of 17.30. However, the intact class after being treated with used of practical activities (post-intervention) also had a mean score of 32.10. With these results, the intact class after treatment performed better in the SAT than the intact class before treatment (theoretical aspect). The mean values indicate that there was a 14.80-point

improvement from the pre-test score to the posttest score. Hence, practical activity approach appears to be more effective in teaching science. 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 improve in science performance and progress in science.

The chart in Figure 4.1 further presents the difference in performance of students when tested with SAT.

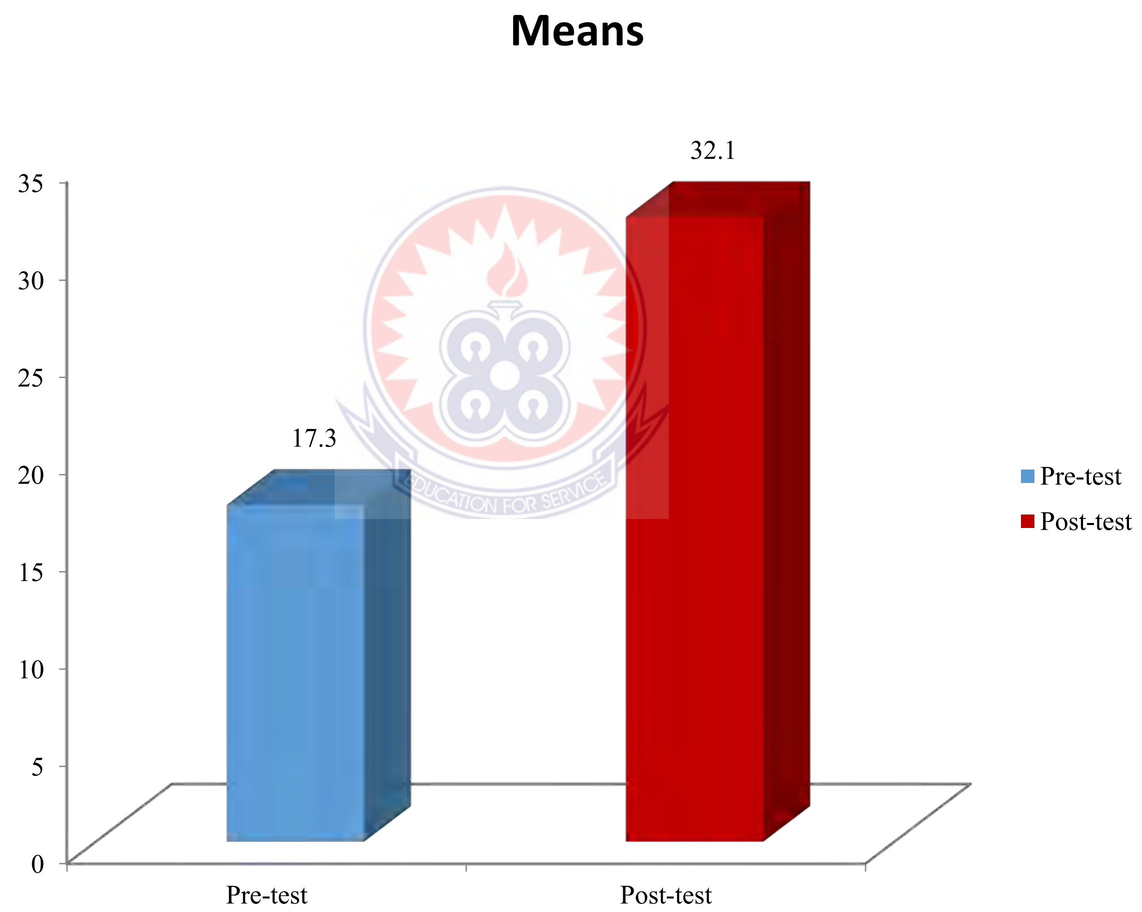

Figure 4.1: Difference in Means of Pre-test and Post-test Performance of Students

The dependent t-test results in (Table 4.2) shows that there is significant difference between the mean posttest and pre-test scores (t = 5.660; p = 0.0001).

Table 4.2: T-test Results Showing the Difference between Mean Pre and Tests Scores

Dependent T-test	T	DF	Sig.(2-tailed)	Mean Difference	Std. Error Difference
Pre- and post- tests Scores.	5.660	98	0.0001	14.800	2.615

From Table 4.2, there was significant difference between mean pre and posttests scores. This implies that the use of practical activities improved the conceptual understanding of the students in selected topics in Integrated Science. The null hypothesis that there is no statistically significant difference between the mean scores of students before and after the intervention was rejected.

4.1.2 Frequent Organisation of Practical Activities aids in Developing the Scientific Inquiry Skills of Students

Research Question 2

How can frequent organisation of practical activities aid in developing the scientific inquiry skills of students?

This question raised in this study was to find out if the use of regular organisation of practical activities had any impact on acquisitions of scientific inquiry skills of students and hence improved their performance. To help students develop scientific inquiry skills needed for Integrated Science practical works, students were taught for four weeks. Each lesson plan was incorporated with laboratory practical activities. The first lesson was on manipulation and setting up of apparatus. Students were guided to identify some basic apparatus. Students were guided to identify some basic apparatus provided after which they were put into respective working groups of ten. Students were then guided to set up apparatus for series of Integrated Science laboratory practical experiments. These practical activities allowed students to observe, measure, manipulate and record Integrated Science laboratory practical experiments and by so doing their scientific inquiry skills and processes were developed. The researcher went round and observed the acquisition of 'Applying knowledge and Practical and Experimental skills' as students performed practical activities in the laboratory on their own.

At the end of each week, students were made to answer few questions based on the inquiry skills and knowledge acquisitions within the week and previous weeks. The test results were given to the students before the next week's lessons start. This enabled students to have enough time to do remediation on the areas they could not do well. Descriptive feedbacks in the form of written comments were provided against incorrect responses. This helped students to know of their mistakes and how to correct them in subsequent assignments. Feedbacks on each assignment were discussed with students so that they could identify what went wrong and what were expected as responses to the questions asked. The data was collected through classroom observation schedule by the researcher during the practical lessons for the period of four weeks. The results of the data were analysed and used to answer the research question. The results from researcher's classroom observation schedule data were converted into percentages.

The following Tables (4.3, 4.4, 4.5, and 4.6) show the analysis of the frequency distribution of level of skills acquisition and percentages of the researcher's classroom observation schedule data after each lesson during the practical lesson.

Table 4.3: Frequency Distribution of Level of Skills Acquisition during Practical Lesson one (1) of the Respondents and their Percentages.

Level of Skills Acquisition	**CAS**		**PAS**		**NAS**	
	F	**%**	**F**	**%**	**F**	**%**
Ability to manipulate scientific apparatus correctly during practical work	32	64	11	22	7	14
Making accurate observations during practical work	20	40	19	38	11	22
Ability to read and record reading values correctly from measuring instruments during practical work	18	36	24	48	8	16
Ability to make accurate interpretation and predictions during practical work	15	30	28	56	7	14

CAS=Correct Acquisition of Skills, PAS=Partial Acquisition of Skills, and NAS=No Acquisition of Skills.

The data analysis of observation schedule of the respondents in the intervention lesson one was investigated with respect to research question two. Data in Table 4.3 showed that out of 50 students 32 (64%) of them exhibited correct acquisition of skills for setting up and manipulation of apparatus; few of them 11 (22%) showed partial acquisition of skills whilst 7 (14%) of the students exhibited no acquisition of skills for setting up and manipulation of apparatus. Similarly, it indicated that 20 (40%) of the students exhibited correct acquisition of skills for accurate observations during practical work whilst only 19 (38%) of them showed partial acquisition of skills and 11 (22%) of the students have their responses as classified as no acquisition of skills for accurate observations during practical work. From the Table 4.3, out of 50 students only 18 (36%) of them exhibited correct acquisition of skills for reading and recording values correctly from measuring instruments during practical work; 24 (48%) of them exhibited partial acquisition of skills whilst as few as 8 (16%) exhibited no acquisition of skills for making measurement. Similarly, only 15 (30%) of students exhibited correct acquisition of skills for making accurate interpretation and predictions whilst as many as 28 (56%) exhibited partial acquisition of skills for making accurate interpretation and predictions. Only 7 (14%) of students exhibited no acquisition of skills for making accurate interpretation and predictions.

Table 4.4: Frequency Distribution of level of Skills Acquisition during Practical Lesson two (2) of the Respondents and their Percentages

Level of Skills Acquisition	**CAS** F	**%**	**PAS** F	**%**	**NAS** F	**%**
Ability to manipulate scientific apparatus correctly during practical work	36	72	12	24	2	4
Making accurate observations during practical work	31	62	16	32	3	6
Ability to read and record reading values correctly from measuring instruments during practical work	29	58	17	34	4	8
Ability to make accurate interpretation and predictions during practical work	23	46	25	50	2	4

CAS=Correct Acquisition of Skills, PAS=Partial Acquisition of Skills, and NAS=No Acquisition of Skills.

The data analysis of observation schedule of the respondents in intervention lesson two was also investigated with respect to research question two. Data in Table 4.4 showed that out of 50 students 36 of them representing about 72% have their responses as classified as correct acquisition of skills whilst 12 of them representing about 24% have their responses classified as partial acquisition of skills for setting up and manipulation of apparatus with only 2 of them representing about 4% have their responses classified as no acquisition of skills for setting up and manipulation of apparatus. Similarly, it was indicated that 31 (62%) of the respondents exhibited correct acquisition of skills for accurate observations during practical work whilst 16 (32%) of the respondents showed partial acquisition of skills and 3 (6%) of the respondents have their responses as classified as no acquisition of skills for accurate observations during practical work. From the Table 4.4 out of 50 respondents 29 (58%) of them exhibited correct acquisition of skills for reading and recording values correctly from measuring instruments during practical work; 17 (34%) of them exhibited partial acquisition of skills whilst as few as 4 (8%) exhibited no acquisition of skills for making measurement. Similarly, only 23 (46%) of respondents exhibited correct acquisition of skills for making accurate interpretation and predictions whilst as many as 25 (50%) exhibited partial acquisition of skills for making accurate interpretation and predictions during practical work. Only 2 (4%) of respondents exhibited no acquisition of skills for making accurate interpretation and predictions during practical work.

Comparing the results from Table 4.3 and Table 4.4, it can be deducted that the levels of correct acquisition of skills have been seen improvement as a result of respondents' frequent exposure to practical activities in the laboratory (64% to 72%, 40% to 62%, 36% to 58%, and 30% to 46%).

Table 4.5: Frequency Distribution of level of Skills Acquisition during practical Lesson three (3) of the Respondents and their Percentages

Level of skills acquisition	**CAS**		**PAS**		**NAS**	
	F	**%**	**F**	**%**	**F**	**%**
Ability to manipulate scientific apparatus correctly during practical work	45	90	5	10	0	0
Making accurate observations during practical work	41	82	9	18	0	0
Ability to read and record reading values correctly from measuring instruments during practical work	42	84	8	16	0	0
Ability to make accurate interpretation and predictions during practical work	41	82	9	18	0	0

CAS=Correct Acquisition of Skills, PAS=Partial Acquisition of Skills, and NAS=No Acquisition of Skills.

The data analysis of observation schedule of the respondents in the intervention lesson three was investigated with respect to research question two. The data provided on Table 4.5 indicated that as many as 45 out of the 50 respondents, representing 90% of them exhibited correct acquisition of skills for setting up and manipulation of apparatus whilst 41 (82%) of respondents exhibited partial acquisition of skills for setting up and manipulation of apparatus. None of the respondents exhibited no acquisition of skills for setting up and manipulation of apparatus. Data from Table

4.5, showed that about 82% of the respondents exhibited correct acquisition of skills for accurate observations during practical work whilst about 18% of the respondents exhibited partial acquisition of skills for accurate observations during practical work. It was also shown in Table 4.5 that none of the respondents exhibited no acquisition of skills for accurate observations during practical work. Similarly, as many as 42 (84%) exhibited correct acquisition of skills for reading and recording values correctly from measuring instruments during practical work whilst only 8 (16%) of respondents exhibited partial acquisition of skills for reading and recording values correctly from measuring instruments with none of the respondents also exhibited no acquisition of skills for reading and recording values correctly from measuring instruments during practical work. About 82% of respondents exhibited correct acquisition of skills for accurate interpretation and predictions during practical work whilst only 18% of the respondents exhibited partial acquisition of skills for accurate interpretation and predictions during practical work. However, none of the respondents exhibited no acquisition of skills for accurate interpretation and predictions during practical work.

Comparing the results analysis from Table 4.4 and Table 4.5, it can be deducted that the levels of correct acquisition of skills of respondents have been improved significantly as a result of their frequent exposure to practical activities in the laboratory work (72% to 90%, 62% to 82%, 58% to 84%, and 46% to 82%). It is clear evident that, most of the students had demonstrated some level of correct acquisition of skills for Integrated Science practical work.

Table 4.6: Frequency Distribution of level of Skills Acquisition during Practical Lesson four (4) of the Respondents and their Percentages

Level of skills acquisition	CAS F	%	PAS F	%	NAS F	%
Ability to manipulate scientific apparatus correctly during practical work	49	98	1	2	0	0
Making accurate observations during practical work	47	94	3	6	0	0
Ability to read and record reading values correctly from measuring instruments during practical work	48	96	2	4	0	0
Ability to make accurate interpretation and predictions during practical work	47	94	3	6	0	0

CAS=Correct Acquisition of Skills, PAS=Partial Acquisition of Skills, and NAS=No Acquisition of Skills.

The data analysis of observation schedule of the respondents in intervention lesson four was also investigated with respect to research question two. Data in the Table 4.6 showed that out of 50 students, 49 (98%) of them exhibited correct acquisition of skills for setting up and manipulation of apparatus whilst only 1 (2%) of the students exhibited partial acquisition of skills for setting up and manipulation of apparatus. However, none of the students exhibited no acquisition of skills for setting up and manipulation of apparatus. Similarly, it was indicated that as many as 47 (94%) demonstrated correct acquisition of skills for accurate observations during practical work whilst only 3(6%) of students exhibited partial acquisition of skills for accurate observations during practical work. From Table 4.6, none of the students exhibited no acquisition of skills for accurate observations during practical work. The data provided in Table 4.6 indicated that as many as 48 out of the 50 respondents, representing 96% of them exhibited correct acquisition of skills for reading and recording values correctly from measuring instruments during practical work whilst only 2 (4%) of the respondents exhibited partial acquisition of skills for reading and recording values correctly from measuring instruments during practical work. The respondents did not exhibit no acquisition of skills for reading and recording values correctly from measuring instruments during practical work. Similarly, it indicated that as many as 47 (94%) demonstrated correct acquisition of skills for accurate interpretation and predictions during practical work whilst just only 3 (6%) exhibited partial acquisition of skills for accurate interpretation and predictions during practical work. As shown by the data provided in Table 4.6, none of the respondents exhibited no acquisition of skills for accurate interpretation and predictions during practical work.

Comparing the results analysis from Table 4.5 and Table 4.6, it can be deducted that the levels of correct acquisition of skills of respondents have been improved significantly as a result of their frequent exposure to practical activities in the laboratory work (90% to 98%, 82% to 94%, 84% to 96%, and 82% to 94%). From the results presented in the Tables, it is clear evident that most of the students had demonstrated correct acquisition of skills for Integrated Science practical work.

This also shows that frequent practical activities in Integrated Science lessons have a significant positive effect on students' performance in Integrated Science.

4.1.3 The Difference between practical activities on males' and females' performance in Integrated Science

Research Question 3

What is the difference between practical activities on males' and females' performance in Integrated Science?

This question raised in this study was to find out if the use of practical activities had any effect on male and female students' academic performance in the study of Integrated Science. As already stated, students of SHS 2 were exposed to different practical activities in the laboratory for four weeks. Each lesson plan was incorporated with different practical activities. Each lesson plan lasted 120 minutes. The students were given Pre-test and Post-test of the Student Achievement Test of Integrated Science practical activity to check the effect of the teaching strategy on male and female students' academic performance. Students' scores in Pre-test and Post-test were used to calculate their average normalized gain in Integrated Science. Table 4.7 gives summary of the descriptive statistics on the Pre-test and Post-test analysis results.

Table 4.7: Comparison of Males' and Females' Performance

Gender		Pre-test Scores	Post-test Scores	Mean Gain Scores
Male	Mean	19.82	38.34	18.52
	Standard Deviation	8.72	14.63	
Female	Mean	17.61	29.57	11.96
	Standard Deviation	6.43	11.91	

The pre-test and post-test findings indicated that the male students had a mean gain score of 18.52 while the female students also had a mean gain score of 11.91. This tentatively suggests that the male students performed better than the female students after being taught using practical activities.

The chart in Figure 4.2 further presents the mean scores of male and female respondents using practical activity approach.

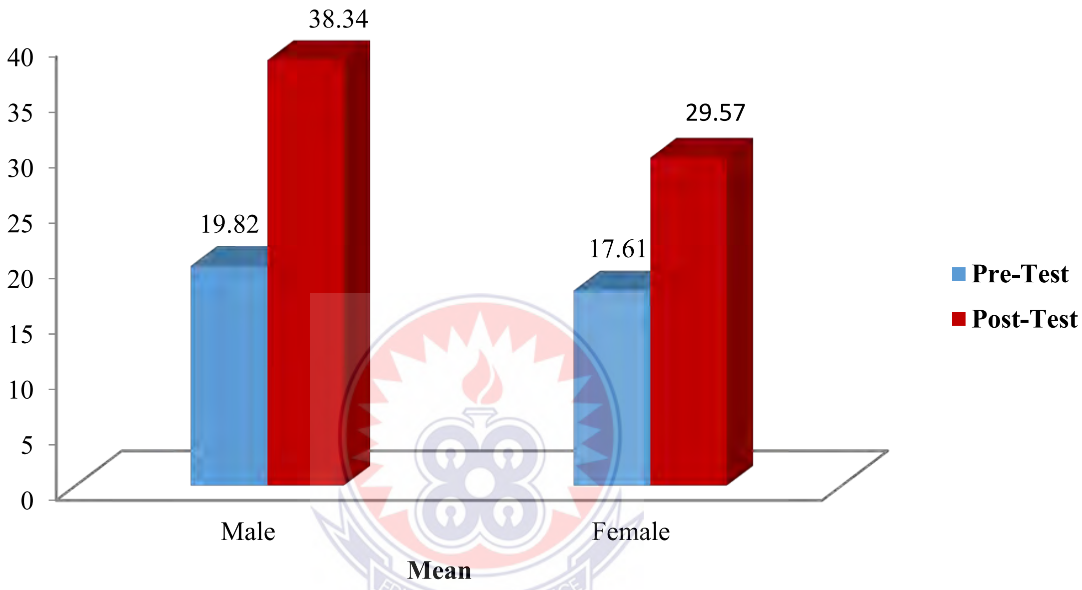

Figure 4.2: Difference in Mean Performance of Male and Female Respondents using Practical Activity Approach

From Table 4.8, there was significant difference between mean scores of male and female students in posttest (t = 2.324, p = 0.024).

Table 4.8: T-test Results showing the Difference the Performance of Male and Female Students during Post test

Variable	t-value	DF	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Male Female	2.324	48	0.024	8.770	3.773

From Table 4.8, there was significant difference between mean scores of students after exposing the students to practical activities. The null hypothesis that there is no significant difference between practical activities on male and female students' performance in Integrated Science was rejected

4.2 Discussions on the Findings

This section discusses the findings obtained from the study on the effect of practical activities on students' academic achievement in some selected topics in Integrated Science. Among other things, it focused on the effect of practical activities on Senior High School students' performance in Integrated Science. It also discussed frequent organisation of practical activities aids in developing the scientific inquiry skills of students as well as the difference between practical activities on males' and females' performance in Integrated Science.

The effect of practical activities on Senior High School students' performance in Integrated Science

The findings related to research question one showed that the intact class after being treated with the use of practical activities performed better in student academic test than the intact class before treatment. The findings showed that the posttest mean score for the intact class was 32.10 and the pre-test mean score for intact class was also 17.30. The mean gain values indicate there was a 14.80-point improvement from the pre-test score to the posttest score. This showed that the performance of the students in the intact class was enhanced after they had been treated with the use of practical activity approach and hence the intervention had a significant positive effect on the students' performance in the selected topics in Integrated Science. This was in agreement with Abdi (2014) who found that practical activity-based learning produced higher scores than traditional teaching methods. It was also in agreement with Vilathong and Popov (2008) who also argued that practical activities enhance understanding of science theory and phenomena. This also confirmed the assertion of Rughnill (2011), Alison (2013), Uche (2018) that students exposed to science practical activities tend to learn more of what is taught, retain it longer, appear more satisfied with their practical work and perform better in examinations than when taught with other instructional formats. This is also in agreement with the empirical investigation reported by Nwagbo (2016), that students learn best when they are actively involved in the learning process. Hence, practical activity approach appears to be more effective in teaching and learning of Integrated Science.

The finding was also in line with Adeniran (2011), Suleman (2010) and Achibong (1997) who found that students exposed to an activity-based approach performed better than students exposed to the lecture method. It was also in agreement with Moog and Spencer (1999) who found that students exposed to Process Oriented Guided Inquiry Learning performed better than those exposed to conventional teaching methods. The findings from the Table 4.1 showed that learning scientific concepts and principles during the teaching and learning of Integrated Science is much better in practical approach than theoretical approach. Science teachers are therefore encouraged to incorporate practical activities into the teaching and learning of scientific concepts and principles. This is because it helps students to construct their own knowledge, and in effect help them better understand scientific concepts and principles.

Frequent organisation of practical activities aids in developing the scientific inquiry of skills of students

The data analysis of observation schedule of the students in the intervention lesson one (1) and the intervention lesson two (2) was investigated with respect to research question two.

The comparative analysis of the results from Table 4.3 and Table 4.4, revealed that the levels of correct acquisition of skills of students had been seen improvement as a result of frequent exposure to practical activities in the laboratory (64% to 72%, 40% to 62%, 36% to 58%, and 30% to 46%). These were indications that students exhibited the needed scientific inquiry skills for practical works.

As the students were exposed to regular weekly intervention laboratory practical exercises and there were regular remediations, their inquiry skills began to improve tremendously. It could be seen that there were significant improvements in students' ability to perform laboratory practical experiments. This is evidence that the intervention strategy adopted (regular organisation of laboratory practical activities) had helped in improving students' skills in performing Integrated Science laboratory practical works.

The data analysis of observation schedule of the students in the intervention lesson two (2) and the intervention lesson three (3) was investigated with respect to research question two.

The comparative analysis of the results from Table 4.4 and Table 4.5, revealed that the levels of correct acquisition of skills of respondents had been improved significantly as a result of their frequent exposure to practical activities in the laboratory work (72% to 90%, 62% to 82%, 58% to 84%, and 46% to 82%). It is clear evident that most of the students had demonstrated some levels of correct acquisition of skills for Integrated Science practical work.

This means the students' ability to carry out Integrated Science practical experiments were, to a large extent, due to the acquisition of scientific inquiry skills they had for Integrated Science practical works. Thus, students were able to develop the skills needed for laboratory practical work because of regular exposure to laboratory practical activities. The analysis of results of weekly intervention laboratory practical activities further confirmed that the improvement in students' output was due to the intervention strategy adopted, thus as students were exposed to laboratory practical activities frequently, they become perfect in carrying out laboratory practical experiments given to them. This finding was in agreement with Brown, Collins and Duguid (1989), Polman (1999), Roth (1995), Wenger (1998), Williams and Hmelo (1998) assertion that learning is contextualized and that learners construct knowledge by solving genuine and meaningful problems. According to Sutherland and Wehby (2001), "students who are actively engaged and provided with frequent opportunities to respond to academic tasks demonstrate improved academic skills." It therefore, became clear that frequent organisation of laboratory practical activities had helped in improving students' ability to carry out laboratory practical experiments successfully.

The data analysis of observation schedule of the students in the intervention lesson three (3) and the intervention lesson four (4) was investigated with respect to research question two.

The comparative analysis of the results from Table 4.5 and Table 4.6, showed that the levels of correct acquisition of skills of the respondents had been improved tremendously as a result of their exposure to the practical activities in the laboratory (90% to 98%, 82% to 94%, 84% to 96%, and 82% to 94%). From the above results of the study, we can clearly notice that there was an increase of level of correct acquisition of skills in each lesson. This also shows that most of the students had demonstrated almost hundred percent of correct acquisition of skills needed for laboratory practical work. This means that practical activities in Integrated Science lessons have a significant positive effect on students' scientific inquiry skills as well as their academic achievement in Integrated Science.

This might be due the fact that frequent practical activities encouraged active participation. This finding was also in consonant with the empirical investigation reported by Nwagbo (2016), that students learn best when they are actively involved in the learning process. This also agrees with Stohr-Hunt (2019) assertion that data from the National Education Longitudinal study indicated that students who engaged in hands-on activities every day or once a week scored significantly higher on a standardized test of science achievement than the students who engaged in hands-on activities once a month, less than once a month or never.

The difference between practical activities on males' and females' performance in Integrated Science

The result of the third research question showed that there was a significant difference in the performance of male and female students after being taught using practical activity approach.

The findings show that the mean gain score for the female students was 11.96 and the mean gain score for the male students was 18.52. The mean gain score values indicate there was a 6.56-point difference from the female students' mean gain score to the male students' mean gain score. This tentatively suggests that male students performed better than the female students after being taught using laboratory practical work. This was in agreement with Brewton (2017), who through the use of different practical activities found that male students outperformed their female counterparts in the physical sciences. This also confirmed the assertion of Ekeh (2004) that male students performed significantly better than their female counterparts in mathematics when taught using iconic models. It was also in agreement with Raimi and Adeoye (2006) in their research on gender differences among college students as determinants of performance in Integrated Science revealed that there was a significant difference between males and females in terms of their attitude towards Integrated Science in favour of males and this was resulted into the better performance of the males in Integrated Science cognitive achievements.

Akpa (2005) states, "how familiar students are to what is expected of them and what sex role stereo type they are attached to could influence how they perform in both practical and theoretical aspects of chemistry examination". Research study carried out by Mari (2001), which focused mostly on the effect of gender factors on students' understanding of science process skills in science learning among junior secondary schools' students showed that there was significant difference between the male and female students in their ability to solve problems requiring their understanding of the process skills. Elsewhere observations on the disparity in male-female performance in sciences exist (Sempala, 2005; Hodson, 1999). Studies carried out by Bell (2001) and

Burns (1987) in UK and New Zealand respectively also showed that male students outperformed their female counterparts in the physical science.

It is evident from these analyses that there is a gap between male and female students in terms of performance. The findings of the study point to the fact that the gap marginal is not all that wide such that it cannot be closed up. In order to close this gap, it is important to promulgate science educational policies that will whip up the female students' interest and motivate them to compete with their male counterparts. It is only by achieving this and that gap in the performance can be closed.

This research contributes to understanding of the importance of incorporating practical activities into science lessons in order to make participation in activities of the science lesson more engaging and interesting to all learners. Furthermore, it examines the effect of practical activities on students' academic achievement in some selected topics in Integrated Science. This research work also emphasised the need of regular organisation of practical work which aids in developing of students' scientific inquiry skills in the learning process. The acquisition of scientific inquiry skills which will help students apply scientific principles and technology to enhance learning and ultimately improve upon the standard of life.

It also emphasised the need for Integrated Science teachers should ensure that both male and female students are actively involved in laboratory practical activities and should give everybody opportunity to participate irrespective of gender. This will go a way to enhance students' knowledge during Integrated Science laboratory practical activities.

CHAPTER FIVE

SUMMARY, CONLUSIONS AND RECOMMENDATIONS

5.0 Overview

This chapter focuses on the summary of the research findings, identifies implications, states the major conclusions of the study and finally gives recommendations on how to improve upon methods of teaching and learning of study of science. The chapter also makes suggestions for further research.

The purpose of this study was to investigate the effect of practical activities on students' academic achievement in some selected topics in Integrated Science at Wa Islamic Senior High School in Wa Municipality of Upper West Region of Ghana. The following objectives guided this study: determine effect of practical activities on SHS 2 students' performance in Integrated Science, use frequent organisation of practical activities to develop and improve upon the scientific inquiry skills of students, and determine the difference between male and female students' performance in Integrated Science.

The review of related literature focused on the senior high school Integrated Science instruction, performance in senior high school Integrated Science, nature of Integrated Science practical activities, aims and objectives of laboratory practical works at senior high, the importance of laboratory practical works in science education, the frequency of Integrated Science practical activities and students' performance, gender and performance in senior high school integrated science, scientific inquiry skills to be developed for practical work, aims of science resource centre manual and theoretical framework.

The study was conducted in one of the public Senior High Schools in the Wa Municipality of the Upper West Region of Ghana. The study involved fifty (50) SHS 2 students of the intact class of Wa Islamic Senior High School.

The research instruments used in the study include: student achievement test (pre-test and posttest) and classroom observation schedule. The data from student achievement tests and classroom observation schedule results was displayed using descriptive statistics and analysed with SPSS.

5.1 Summary of the Research Findings

The study found that there was a significant difference of the mean scores of students when being taught using practical activities. The posttest results showed that the intact class had a mean score of 32.10 while the pre-test results also showed intact class had a mean score of 17.30. The mean values indicate that there was a 14.8-point improvement from the pre-test score to the posttest score. This showed that the performance of the intact class was enhanced after they had been using the practical activity approach and hence the intervention had a significant positive effect on the students' performance in some selected topics in Integrated Science. This shows that the use of practical activity approach had a significant improvement in the performance of the Integrated Science at Islamic Senior High School and it is a better instructional approach of teaching and learning of Integrated Science.

The main findings related to research question two.

The comparative analysis of the results from Table 4.3, 4.4, 4.5 and 4.6 showed that the levels of correct acquisition of skills of students had been seen improvement as a result of frequent exposure to practical activities in the laboratory (64% to 72%, 40%

to 62%, 36% to 58%, and 30% to 46%). These were indications that students exhibited the needed scientific inquiry skills for practical works.

The comparative analysis of the results from Table 4.4 and Table 4.5, showed that the levels of correct acquisition of skills of respondents had been improved significantly as a result of their frequent exposure to practical activities in the laboratory (72% to 90%, 62% to 82%, 58% to 84%, and 46% to 82%). It is clear evident that most of the students had demonstrated some levels of correct acquisition of skills for Integrated Science practical work.

The comparative analysis of the results from Table 4.4 and Table 4.5, showed that the levels of correct acquisition of skills of the respondents had been improved tremendously as a result of their exposure to the practical activities in the laboratory (90% to 98%, 82% to 94%, 84% to 96%, and 82% to 94%). From the above results of the study, we can clearly notice that there was an increase of level of correct acquisition of skills in each lesson. This also shows that most of the students had demonstrated almost hundred percent of correct acquisition of skills needed for laboratory practical work.

The study also found that there was a significant effect of practical activities on male and female students' academic achievement in Integrated Science. The study also found that there was a significant effect of practical activities on the mean scores of male students than their female counterparts. The posttest results showed that the female students had a mean gain score of 11.96 while the male counterparts had a mean gain score of 18.52. From the findings, the male students' mean gain score is higher than the female counterparts' mean gain scores, implying that there was a significant difference in posttest performance in Integrated Science between male and female students exposed to practical activities.

5.2 Conclusions

The students of the intact class took a posttest using the student achievement test on both practical activities and without practical activities after they had been taught by the researcher for each intervention lesson. It was concluded that the use of practical activities enhanced better performance of students in Integrated Science.

Laboratory practical works as means of developing students' scientific inquiry skills is wide acknowledged in journals and other educational literature. It is believed that teachers have been taking their students through science practical activities yet students could not perform competently as far as science practical work is concerned. The findings of this study revealed that frequent organisation of practical activities and frequent exposure of students to laboratory practical activities exert potent and positive influence on the development of scientific inquiry skills of students. These strategies helped students to develop the scientific inquiry skills needed for laboratory practical works. Thus, as students were exposed to regular laboratory practical works and frequent practices, their ability to carry out Integrated Science laboratory practical works were enhanced. Thus, as regular organisation of laboratory practical activities and frequent exposure to laboratory practical exercises are therefore identified as ideal strategies that could help students develop the needed scientific inquiry skills for laboratory practical works.

Practical activity approach, being an activity-oriented model, enhanced better performance among male students compared with female students. This might be because the male students had better affinity for such activities and ability to work together as a team than female students.

5.3 Implications of the Findings for Classroom Instruction

The findings of the study indicated that frequent organisation of laboratory practical activities and regular exposure of students to laboratory practical exercises enhance the development of scientific inquiry skills of students. Frequent organisation of laboratory practical activities and provision of practical exercises for students to practice with regularly motivates students to learn more. Cumulative assessments which involve frequent exposure of students to laboratory practical exercises may be quite useful in promoting the development of scientific inquiry skills of the students. The laboratory practical exercises stimulate students to learn concepts for practical works in details that would not be learned for examination. This makes students see examination questions as one of the usual laboratory practical exercises hence easier to perform. Regular organisation of laboratory practical activities and frequent exposure to laboratory exercises make students to continuously revise the skills for laboratory practical works throughout the term instead of waiting till final examination time. The practical task performed by the students in the laboratory should be more challenging since this will enable the teacher to judge a student from his or her performance give suggestions accordingly.

5.4 Recommendations

Based on the findings of the study and the conclusions, the following recommendations are made:

1. Teachers of Integrated Science should make conscious efforts to organise laboratory practical works alongside the theory to enable students acquire the needed skills for practical works from the onset of their course of study and this should be done on regular basis.
2. Students should be given the chance to practice the laboratory practical skills acquired regularly to enable them carry out laboratory practical works successfully on their own.

5.5 Suggestions for further Research

Since we are in an educational reform era, there is room for further research on any aspect of the Integrated Science laboratory practical works at senior high school level. The study therefore makes the following suggestions for the improvement of this area of study and further research:

1. Studies could be undertaken to investigate the effect of students' attitudes towards practical lessons on the development of scientific inquiry skills of students.
2. Again, further studies could be undertaken to establish the effects of the sole use improvised materials in teaching laboratory practical lessons in relation to the development of the skills needed for laboratory practical works.
3. A research could also be carried out to find out whether the Qualifications and Area of Specialisation of the teacher has any influence on teaching of

Integrated Science laboratory practical works so that an appropriate decision could be taken.

4. More works need to be done to find out whether student and teacher motivation could have any influence on the teaching and learning of Integrated Science at the senior high school level.

5. The study was conducted in the Wa Islamic Senior High School, which limited the generalisation of the findings from the study to cover all the senior high schools in Ghana. It is therefore suggested that further research could involve more senior high schools for the possibility of wider generalisation of the findings from the study.

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APPENDICES

LIST OF APPENDICES

APPENDIX ONE

SAMPLE LESSON PLANS

Lesson	One (1)
Subject	Integrated Science
Topic	Electricity and Basic Electronics
Subtopic	Simple circuit-voltmeter, ammeter and unknown resistor
RPK	Students have treated series and parallel arrangements of cells and resistors
Objectives	By the end of the lesson, the learner will be able to; 1. Identify at least 3 components of a simple electric circuit 2. Connect a simple electric circuit 3. Read ammeter and voltmeter and record their readings correctly
Duration	120 minutes
Class	SHS 2
TLMs	Connecting wires, ammeter, voltmeter, keys, cells, power source, resistors, Task cards
References	Teaching syllabus for Integrated Science (SHS 1-3) pp. 30, Practical Physics for SHS (p.11).
Remarks	

TLM	Content/Time	Teacher Activities	Student Activities	Major Ideas/ Core Points
	Introduction Review of students' RPK (10 minutes)	Teacher introduces lesson by reviewing students' RPK using the question and answer method. Mention any 3 components of a simple electric circuit	Expected responses: Cell, key, resistor, connecting wire	

	Development **Step 1** Identification of components of a simple electric circuit (20 minutes)	Teacher shows a chart depicting a simple electric circuit to students to observe and discuss	Students discuss the functions of the components of an electric circuit	Components of an electric circuit
Task cards, battery, key, connecting wires, ammeter, voltmeter, resistors	Development **Step 2** Connecting of a simple electric circuit (50 minutes)	Teacher guides students to constitute various groups comprising five students each. Teacher then distributes task cards on connecting of a simple electric circuit	The groups collect the task cards and follow the instructions to connect a simple electric circuit	Simple electric circuits. Series and parallel arrangements of components
	Step 3 Read ammeter and voltmeter and record their readings correctly. (30 minutes)	Teacher shows students how readings of ammeter and voltmeter can be read and recorded correctly	Students listen attentively to teacher and watch while he reads and records the readings. The various groups also read ammeters and record their readings.	
	Evaluation (10 minutes)	1. Draw a simple electric circuit 2. State the functions of the following components of an electric circuit; i. Battery ii. Switch iii. Resistor		

Lesson	Two (2)
Subject	Integrated Science
Topic	Acid, bases, Salt and Indicators
Subtopic	pH scales and indicators
RPK	Students have treated Acids and Bases at JHS
Objectives	By the end of the lesson, the learner will be able to; 1. Classify chemical substances as acid, base or neutral 2. Measure the pH of a given solution 3. Describe the effects of acid-base indicators
Duration	120 minutes
Class	SHS 2
TLMs	Pure water, sea water, orange juice, palm oil, soap, common salt, Aspirin, tomato juice, Liquid in car battery, pH paper, pH meter, Phenolphthalein, litmus paper, methyl orange
References	Teaching syllabus for Integrated Science (SHS 1-3) pg 21, Aki-Ola Series Integrated Science for SHS pg 274
Remarks	

TLM	Content/ Time	Teacher Activities	Students Activities	Major Ideas/ Core points
	Introduction Review of students' RPK (10 minutes)	Teacher introduces lesson by reviewing students' RPK using the question and answer method. State 2 properties of each of the following; i. Acid ii. Base	Expected responses; Properties of acids - Have sour taste - Have pH of less than 7 - Turn blue litmus red Properties of bases - They have bitter taste - Their pH is greater than 7 - They change red litmus blue	
	Development	Teacher uses litmus paper to	Students listen	Orange

Orange juice, sea water, soap, pure water, common salt, tomato juice Task cards	**Step 1** Classify chemical substances as acid, base or neutral (20 minutes)	demonstrate to students how to classify chemical substances as acid, base, neutral Teacher guides students to constitute various groups comprising five students each. Teacher then distributes chemical substances to the groups	attentively to teacher and watch while he conducts the simple experiment to classify chemical substances as acid, base or neutral The groups collect the chemical substances and follow the instructions to conduct the experiment to classify chemical substances as acid, base or neutral	juice- acid Sea water- base, Soap- base, Pure water- neutral, Common salt- neutral, Tomato juice- acid
Task cards Universal indicator Solution Test tube Standard colour chart Car battery Vinegar Local soap	Development **Step 2** Measure the pH of a given solution (40 minutes)	Teacher demonstrates how the use of the universal indicator and the pH meter in the determination of the pH of common household chemicals eg. Vinegar, palm oil, local soap and shampoo Teacher distributes task cards on measurement of pH using a universal indicator solution	Students observe the demonstration The groups collect the task cards and follow the instructions to measure the pH of the following chemical substances; Car battery, vinegar and local soap	
	Development **Step 3** Describe the effects of acid-base indicators	Teacher guides students to constitute various groups comprising five students each. Teacher then distributes task cards on describing the colours developed by phenolphthalein, litmus and	The groups collect the task cards and follow the instructions to carry out the experiment Record the resulting colour changes in	

	(40 minutes)	methyl orange in aqueous solutions of dil HCl, dil NaOH, distilled water	each test tube	
	Evaluation (10 minutes)	1. Explain how to determine the pH of a given solution 2. Which is more acidic: a solution of pH =1 or a solution of pH = 9?		

Lesson Three (3)

Subject Integrated Science

Topic Food and Nutrition

Subtopic Food Test

RPK Students have treated classes of Food at JHS

Objectives By the end of the lesson, the learner will be able to;

1. Identify the five main types of food test
2. Test at least 3 main types of the following food substances and observe their colour changes:
   (i) Glucose
   (ii) Starch
   (iii) Sucrose
   (iv) Protein
   (v) Fats and oils (lipids)

Duration 120 minutes

Class SHS 2

TLMs Test tube, iodine solution, Benedict's solution, Fehlings solution A and B, dil. HCl, Sodium hydrogen carbonate, eggs, milk, yam, glucose, Biuret test, Million's test, Palm oil. Groundnut oil, Sudan III, ethanol, task cards

References Teaching syllabus for Integrated Science (SHS 1-3) pg 11, Aki-Ola Series Integrated Science for SHS pg 158

Remarks

TLM	Content/Time	Teacher Activities	Student Activities	Major Ideas/ Core Points
	Introduction Review of students' RPK (10 minutes)	Teacher introduces lesson by reviewing students' RPK using the question and answer method. Mention the six classes of food	Expected responses: Carbohydrate, protein, vitamin, fats and oils, mineral and water	
	Development **Step 1** 1. Identify the five main types of food test (20 minutes)	Teacher discusses on classes of food and food substances from the Integrated Science syllabus	Students listen attentively to teacher and ask questions for clarification	Nutrients Protein Lipids Starch Glucose
Test tube, eggs, milk, yam, palm oil, Benedict's solution, Biuret test, Million's test, ethanol	Development **Step 2** 2. Test the following food substances and observe their colour changes: (i) Glucose	Teacher guides students to constitute various groups comprising five students each. Teacher then distributes task cards on testing food substances and observe their colour changes	Students' groups collect the task cards and follow the instructions to carry out the experiment. Record the resulting colour	

Sudan III solution Task cards	(ii) Starch (iii) Sucrose (iv) Protein (v) Lipids		changes in each test tube	
	Evaluation (80 minutes)	State the functions of each of the following food substances: **Food substances** — **Function** Fats and oils — .... Proteins — .... Vitamins — .... Mineral salts — .... Water — .... Roughage —		

Lesson Four (4)
Subject Integrated Science
Topic Lab Preparation and Test of Gases

Subtopic Lab Preparation and Test of hydrogen, oxygen and carbon dioxide

RPK Students have treated acids and bases and their properties
Objectives By the end of the lesson, the learner will be able to;
1. Identify hydrogen, oxygen and carbon dioxide based on their properties
2. Test for hydrogen, oxygen and carbon dioxide
3. Prepare hydrogen, oxygen and carbon dioxide in laboratory

Duration 120 minutes

Class SHS 2

TLMs HCl/H_2SO_4, Zinc metal, H_2O_2, dil HCl, $CaCO_3$, Beehive, cork, delivery tube, test tube, MnO2, trough, inverted cylinder, thistle funnel, conical flask, flat bottomed flask, glowing splint, lime water

References Teaching syllabus for Integrated Science (SHS 1-3) pg 21, Aki-Ola Series Integrated Science Practical

Remarks

TLM	Content/Time	Teacher Activities	Student Activities	Major Ideas/Core Point
	Introduction Review of students' RPK (10 minutes)	Teacher introduces lesson by reviewing students' RPK using the question and answer method State 2 properties of each of the following; (i) acid (ii) base	Expected responses; Properties of acid - Have sour taste - Have pH of less than 7 - Turn blue litmus red Properties of bases - They have bitter taste - Their pH is greater than 7 - They change red litmus blue	
	Development **Step 1** 1. identify hydrogen, oxygen and carbon dioxide based on their properties (20 minutes)	Teacher explains the properties of hydrogen, oxygen and carbon dioxide to students	Students listen attentively to the teacher	
Test tube, glowing splint, a	**Step 2** 2. Test for hydrogen, oxygen and carbon	Teacher guides students to constitute various	The groups collect the task cards and	

lighted candle, lime water Task cards	dioxide (40 minutes)	groups comprising five students each. Teacher then distributes task cards on testing for hydrogen, oxygen and carbon dioxide	follow the instructions to carry out the experiment	
Zinc metal, HCl, cork, conical flask, trough, inverted cylinder, thistle funnel	**Development** **Step 3** Prepare hydrogen, oxygen and carbon dioxide (40 minutes)	Teacher demonstrates how to prepare the gases in the laboratory	The students carefully observe the experiments while the teacher carries out the demonstration in the laboratory	
	Evaluation (10 minutes)	Three gas jars containing hydrogen, oxygen and carbon dioxide and ammonia have lost their labels in the laboratory. Using a table, indicate the tests, observations and conclusions that can enable you to identify each of the gases		

APPENDIX TWO

PRE-TEST INTERVENTION

STUDENT ACHIEVEMENT TEST (PRE-TEST)

General Instruction

Please indicate your response by ticking like this [√] in the appropriate bracket and fill in the blank spaces provided where applicable.

SECTION A

BACKGROUND INFORMATION OF RESPONDENT

Class: …………………………… Date: …………………………………………..

Gender: Male [ ] Female [ ]

SECTION B

This test paper consists of four (40) questions. Answer all questions.

Time allocated is 60 minutes.

1. (a) The test tube for a type of food substance in a given sample involves the following steps which are not necessarily arranged in order.

I. Add 1% copper sulphate solution drop by drop whilst shaking the mixture.

II. Violet coloration appears.

III. Pour little of the sample into a test tube.

IV. Add $10cm^3$ of dilute sodium hydroxide to the sample in the test tube.

Rearrange and copy the above in order in which they should occur.

………………………………………………………………………………….

………………………………………………………………………………….

………………………………………………………………………………….

(b) Which food substance could be tested for using the above steps?

………………………………………………………………………………….

5 marks

2. **(a)** Describe briefly what would be observed in each of the following activities in the laboratory:

i. A glowing splint is placed in a gas jar containing oxygen gas

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

ii. A burning match is placed in a gas jar of hydrogen;

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

b. Write balanced chemical equations to illustrate the answers in **(i)** above.

……………………………………………………………………………………

……………………………………………………………………………………

5 marks

3. Figure 3 below is an illustration of an electric circuit. Study the figure carefully and answer the questions that follow

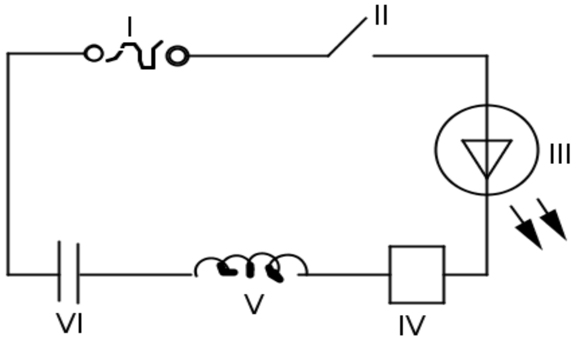

Figure 3

(i) Name the parts labeled **I**, **II**, **III**, **IV**, **V** and **VI.**

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

(ii) If the part labeled **II** is closed, state the type of energy stored in each of the parts labeled **V** and **VI**.

………………………………………………………………………………………

………………………………………………………………………………………

(iii) List five appliances that use that part labeled **III**

………………………………………………………………………………………

………………………………………………………………………………………

5 marks

4. If three different liquids, namely, dilute acid, distilled water and alkaline solutions are placed in three identical unlabeled bottles and presented to you for identification.

(i) Describe the procedure you would use for the identification

……………………………………………………………………………………..

……………………………………………………………………………………..

……………………………………………………………………………………..

……………………………………………………………………………………..

(ii) Give reasons for using the procedure you have described.

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

5 marks

APPENDIX THREE

POST-TEST INTERVENTION

STUDENT ACHIEVEMENT TEST (POST-TEST)

General Instruction

Please indicate your response by ticking like this [√] in the appropriate bracket and fill in the blank spaces provided where applicable.

SECTION A

BACKGROUND INFORMATION OF RESPONDENT

Class: …………………………………… Date: ……………………………………………

Gender: ☐ Male ☐ Female

SECTION B

This test paper consists of four (4) questions. Answer all questions.

Time allocated is 60 minutes.

1. **(a)** In testing for a certain food substance, the following steps are required:

I. Heat the test tube until contents boil.

II. Pour a little of the sample into the test tube.

III. Brick-red precipitate appears.

IV. Pour a little Benedict's solution into the test tube.

Rearrange and copy the above in order in which they should occur.

…………………………………………………………………………………

…………………………………………………………………………………

………………………………………………………………………………....

…………………………………………………………………………………

(b) Which food substance could be tested for using the above steps?

……………………………………………………………………………

5 marks

2. **(a)** Describe briefly the test that could be performed in the laboratory to identify each of the following gases:

(i) Carbon dioxide

………………………………………………………………………………

………………………………………………………………………………

………………………………………………………………………………

(ii) Hydrogen

………………………………………………………………………………

………………………………………………………………………………

………………………………………………………………………………

(b) Write balanced chemical equations to illustrate the answers in **(a)** above.

………………………………………………………………………………….

5 marks

3. Figure 3 below is an illustration of a simple electrical circuit. Study the figure carefully and answer the questions that follow.

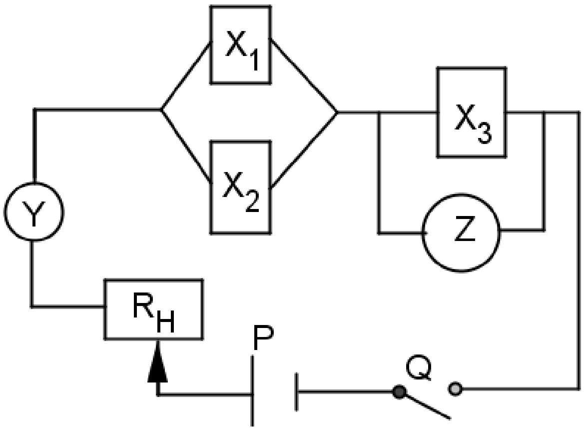

Figure 3

a. **(i)** Identify the components labeled **Y**, **Z**, **X**$_1$, **P**, **Q** and **R**$_H$.

....

....

....

3 marks

(ii) State the unit of measurement of readings on **Y** and **Z**.

…………………………………………………………………………

…………………………………………………………………………

1 mark

b. Describe briefly the arrangements of all the components in the circuit.

…………………………………………………………………………………

…………………………………………………………………………………

3 marks

c. Give the direction of the conventional current when the circuit is closed.

…………………………………………………………………………………

…………………………………………………………………………………

1 mark

d. State one function each of

(i) R_H……………………………………………………………………

(ii) Q……………………………………………………………………

(iii) Y…………………………………………………………………...

(iv) Z……………………………………………………………………

2 marks

4. Samples of the substances, aqueous sodium chloride, lime juice, caustic soda and battery acid were tested with litmus solution. The observations made are as shown in the table below.

Activity	**Observation**	**Name of Substance**
Substance + litmus solution	No visible colour change	
Substance + litmus solution	Colour changed to pale red	
Substance + litmus solution	Colour changed to blue	
Substance + litmus solution	Colour changed to deep red	

(i) For each of the observation stated, write down the name(s) of the substance(s) most likely to give that observation in the spaces provided in the table.

…………………………………………………………………………………….

……………………………………………………………………………………..

……………………………………………………………………………………..

……………………………………………………………………………………..

(ii) Arrange the substances in order of increasing pH.

………………………………………………………………………………………

………………………………………………………………………………………

5 marks

APPNEDIX FOUR

MARKING SCHEME

PRE-TEST

1. **(a) II.** Pour a little of the sample into the test tube

IV. Add $10cm^3$ of sodium hydroxide solution to sample in test tube

I. Add 1% copper sulphate solution drop-by-drop, shaking at each drop

II. Violet coloration appears

4×1= 4 marks

(b) Protein

1 mark

2. **(a) (i)** The glowing splint is rekindled or relit because oxygen supports combustion or burning.

$1\frac{1}{2}$ ***marks***

(ii) A 'pop' sound is heard because the reaction between hydrogen and oxygen in the presence of heat is explosive.

$1\frac{1}{2}$ ***marks***

(b) (i) Balanced chemical equation for test for oxygen

$$2H_2O_{2(aq)} \xrightarrow{MnO_{2(s)}} 2H_2O_{(l)} + O_{2(g)}$$

1 mark

(ii) Balanced chemical equation for test for hydrogen

$$2H_2 + O_2 \rightarrow 2H_2O$$

1 mark

3. **(i)** ***NAME OF LABELLED PARTS***

I- AC Source

II- Key/Switch

III- Light emitted diode/LED

IV- Resistor

V- Inductor/Coil/Solenoid

VI- Capacitor

$6 \times \frac{1}{2} = 3\ marks$

(ii) ***TYPES OF ENERGY STORED IN PARTS LABELLED* V *AND* VI**

V- Electrical energy

VI- Magnetic energy

2×1=2 marks

(iii) ***APPLIANCES***

Torch light	-Television
Car tail light	- Radio
Traffic light	- Electric iron
Electric lamps/ electric bulb	- Remote control

Any 5×1=5 marks

4. **(i)** Place blue litmus paper in each of the 3 solutions

- The solution that turns blue litmus red is the acid
- Put red litmus in the remaining two solutions
- The solution that turns the red litmus blue is the alkaline
- The water does not have effect on litmus paper.

Any 4×1= 4 marks

OR

- Place blue and red litmus papers in each of the 3 solutions.

- The solution that turns blue litmus red is acid.
- The solution that red litmus blue is alkaline.
- The solution that does not have effect on litmus papers is distilled water.

4×1= 4 marks

(ii) ***REASONS FOR USING THE PROCEDURE ABOVE***

Litmus paper has different colour in acids and bases have no colour change in water.

1 mark

APPENDIX FIVE

MARKING SCHEME

POST-TEST

1. **(a)** II. Pour a little of the sample into the test tube.

IV. Pour a little Benedict's solution into the test tube.

I. Heat the test tube until content boils.

III. Brick-red precipitate appears

4×1= 4 marks

(b) Glucose

1 mark

2. **(a) (i)** ***Carbon dioxide***

Pass carbon dioxide through lime water. The solution turns milky.

$1\frac{1}{2}$ *marks*

(ii) ***Hydrogen***

Place the lighted or glowing splint in hydrogen and there is a pop sound.

$1\frac{1}{2}$ *marks*

(b) *Balance chemical equation for test for Carbon dioxide*

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$$

1 mark

(ii) *Balanced chemical equation for test for hydrogen*

$$2H_2 + O_2 \rightarrow 2H_2O$$

1 mark

3. **(i)** ***NAME OF LABELLED PARTS;***

Y- Ammeter

Z- Voltmeter

X_1- Standard resistor

P- Cell

Q- Key/Switch

R_H- Rheostat/Variable resistor

$6 \times \frac{1}{2} = 3$ *marks*

(ii) ***THE UNIT MEASURE OF READINGS ON* Y *AND* Z**

Y- ampere A

Z- volt V

$2 \times \frac{1}{2} = 1\ mark$

(b) ***DESCRIPTION OF ALL THE COMPONENTS IN THE CIRCUIT***

- $\mathbf{X_1}$and $\mathbf{X_2}$are standard resistors connected in parallel.

- The combination is connected in series with resistor $\mathbf{X_3}$, ammeter **Y**, rheostat $\mathbf{R_H}$, cell **P** and key **Q**.

- Voltmeter **Z** is connected across resistor $\mathbf{X_3}$

$3 \times 1 = 3\ marks$

(c) The conventional current flows from the positive plate or pale or terminal to the negative plate or pole or terminal.

1 mark

(d) (i) ***Functions of*** R_H

Varies the current or resistance in the circuit.

(ii) ***Functions of Q***

Closes or opens the circuit.

(iii) ***Functions of Y***

Measures the current in the circuit.

(iv) ***Functions of Z***

Measures potential difference across $\mathbf{X_3}$

$4 \times \frac{1}{2} = 2\ marks$

4. (i) Table

Activity	**Observation**	**Name of Substance**
Substance + litmus solution	No visible colour change	**Aqueous sodium chloride**
Substance + litmus solution	Colour changed to pale red	**Lime juice**
Substance + litmus solution	Colour changed to blue	**Caustic soda**
Substance + litmus solution	Colour changed to deep red	**Battery acid**

$\boldsymbol{4\times 1 = 4\ marks}$

(ii) *SUBSTANCES ARRANGED IN ORDER OF INCREASING pH*

Battery acid, lime juice, aqueous sodium chloride and caustic soda.

1 mark

APPENDIX SIX

FORM 2 INTEGRATED SCIENCE SCHEME OF WORK

Wk	Lesson	Topic/Subtopic	Lesson Objectives	Learning Activities	Learning Resources/ References	Remarks
2	1	**TOPIC** ELECTRICITY Basic circuit symbols Reading of Ammeter and Voltmeter **SUB TOPIC** ELECTRONICS	By the end of the lesson, the learner will be: - identify basic circuit symbols in a given circuit - read ammeter and voltmeter and record their readings correctly -verify Ohm's law By the end of the lesson, the learner will be able to; - identify basic circuit symbols in a given electronic circuit - connect a simple electronic circuit	**CLASS DISCUSSION** ON: identify basic circuit symbols in a given circuit **DEMONSTRATION** EXPERIMENT ON: reading of ammeter and voltmeter Verifying Ohm's law **DEMONSTRTATION EXPERIMENT** ON: identifying of basic electronic symbols in a given circuit connecting of electronic circuit	Cells, Keys connecting wires, bulb, resistors, ammeter, voltmeter Integrated science textbook Integrated science practical textbook Int. Science Syllabus Capacitors Inductors LED Resistor Connecting wires Key	

	2	Acids, Bases, Salts and Indicators	By the end of the lesson, the learner will be able to: - classify chemical substances as acid, base or neutral - prepare sodium chloride by the neutralization method	**CLASS DISCUSSION** ON: Classifying of chemical substances as acid, base or neutral **DEMONSTRATION** **EXPERIMENT** ON: Preparing of sodium chloride by the neutralization method	Pure water Sea water Orange juice Palm wine soap Comm on salt, Aspirin Tomato juice Blood, Lye soap Tooth paste Pipette, burette Conical flask, HCl, NaOH, evaporating dish, indicator Bunsen burner, tripod gauze	
4	3	FOOD AND NUTRITION Food Test Test for reducing sugars Test for non reducing sugars Test for protein Test fir fats and oils Test for starch	By the end of the learner will be able to: - identify the five main types of food test - test the following food substances and observe their colour changes a. glucose b. starch c. sucrose d. protein	**CLASS DISCUSSION** ON: identifying of types of food substances **DEMONSTRATION** **EXPERIMENT** ON: testing of food substances	pH paper pH meter universal indicator solution Phenolphthalein Litmus paper Methyl orange Dilute acid Dilute base	
5	4	Lab Preparation and Test of Gases (Hydrogen,	By the end of the lesson, the learner	**DEMONSTRATION** **EXPERIMENT**	HCl/H_2SO_4, Zinc metal, H_2O_2, MnO_2, dil HCl,	

		oxygen and carbon dioxide)	will be able to; - identify hydrogen, oxygen and carbon dioxide - test for hydrogen, oxygen and carbon dioxide - prepare hydrogen, oxygen and carbon dioxide in the lab	ON: identifying of hydrogen, oxygen and carbon dioxide Testing of hydrogen, oxygen and carbon dioxide Preparing of hydrogen, oxygen and carbon dioxide in the lab	$CaCO_3$, Beehive, Cork, delivery tube, trough, inverted cylinder, thistle funnel, conical flask, flat bottomed flask, test tube	

APPENDIX SEVEN

Classroom Observation Schedule (COS)

Lesson One (1)

Section A: General Information

Subject: ______________________________ Class: __________________________

No of Students: ________________________ Sex of Student: ___________________

Section B: Development of Scientific Inquiry Skills

Key: **CAS-Correct Acquisition of Skills**, **PAS-Partial Acquisition of Skills**, and **NAS-No Acquisition of Skills**.

Development of Scientific Inquiry Skills	**CAS**	**PAS**	**NAS**
Ability to manipulate scientific apparatus correctly during practical work			
Making accurate observations in Integration Science practical work			
Ability to read and record reading values correctly from measuring instruments during practical work			
Ability to make accurate interpretation and predictions during practical work			

APPENDIX EIGHT

Classroom Observation Schedule (COS)

Lesson Two (2)

Section A: General Information

Subject: ______________________________ Class: __________________________

No of Students: ________________________ Sex of Student: ___________________

Section B: Development of Scientific Inquiry Skills

Key: **CAS-Correct Acquisition of Skills**, **PAS-Partial Acquisition of Skills**, and **NAS-No Acquisition of Skills**.

Development of Scientific Inquiry Skills	**CAS**	**PAS**	**NAS**
Ability to manipulate scientific apparatus correctly during practical work			
Making accurate observations in Integration Science practical work			
Ability to read and record reading values correctly from measuring instruments during practical work			
Ability to make accurate interpretation and predictions during practical work			

APPENDIX NINE

Classroom Observation Schedule (COS)

Lesson Three (3)

Section A: General Information

Subject: ______________________________ Class: __________________________

No of Students: _______________________ Sex of Student: ___________________

Section B: Development of Scientific Inquiry Skills

Key: **CAS-Correct Acquisition of Skills**, **PAS-Partial Acquisition of Skills**, and **NAS-No Acquisition of Skills**.

Development of Scientific Inquiry Skills	CAS	**PAS**	**NAS**
Ability to manipulate scientific apparatus correctly during practical work			
Making accurate observations in Integration Science practical work			
Ability to read and record reading values correctly from measuring instruments during practical work			
Ability to make accurate interpretation and predictions during practical work			

APPENDIX TEN

Classroom Observation Schedule (COS)

Lesson Four (4)

Section A: General Information

Subject: ______________________________ Class: __________________________

No of Students: _______________________ Sex of Student: ___________________

Section B: Development of Scientific Inquiry Skills

Key: **CAS-Correct Acquisition of Skills**, **PAS-Partial Acquisition of Skills**, and **NAS-No Acquisition of Skills**.

Development of Scientific Inquiry Skills	**CAS**	**PAS**	**NAS**
Ability to manipulate scientific apparatus correctly during practical work			
Making accurate observations in Integration Science practical work			
Ability to read and record reading values correctly from measuring instruments during practical work			
Ability to make accurate interpretation and predictions during practical work			