UNIVERSITY OF EDUCATION, WINNEBA

GUIDED INQUIRY METHOD: AN APPROACH TO IMPROVE THE PERFORMANCES IN PHYSICS FOR SENIOR HIGH SCHOOL STUDENTS IN GHANA

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DECLARATION

Student's Declaration

I, RAPHAEL AWELAMA AWUKEY, declare that this Thesis, except for quotations and references contained in published works which have all been identified and acknowledged, is entirely my original work and that it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE: ………………………………………………………………….

DATE: ………………………………………………………………………..

Supervisors' Declaration

I hereby declare that the preparation and presentation of this work were supervised under the guidelines for supervision of the thesis as laid down by the University of Education, Winneba.

NAME OF SUPERVISOR: MAWUADEM KOKU AMEDEKER

SIGNATURE: ………………………………………………………………….

DATE: ……………………………………………………………………….

DEDICATION

This work is dedicated to my wife, brother, mother and friends who have been my source of inspiration and helped in divers‘ ways to make this work a success

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Finally, and most importantly, I give the glorious praise and Honour to God, who has seen me through this study, for without Him, this study would not have been successful.

TABLE OF CONTENTS

Content **Page**

LIST OF TABLES

LIST OF FIGURES

Figure **Page**

ABSTRACT

The purpose of this research was to teach students with the guided enquiry approach to enhance the academic performance of Physics students at Nafana Presby Senior High School in the Bono Region of Ghana. The Researcher taught scientific process skills such as manipulating and observing through guided inquiry methods as well as the specific science process skills to students in some classes. The study was a case study design using an Action Research methodology. Thirty-eight students in Form 2 constituted the sample for the study. Class observational checklists and learning packages were used to collect the study's data. The science process skills displayed by the students during the lesson sessions were recorded using the observational checklist. Both quantitative and qualitative analyses were done on the data using tables and graphs. The study's findings demonstrated that after being exposed to the guided inquiry approach, the students was able to demonstrate skills of manipulating, holding, measuring, and observing. There was an improvement on their previous skills of communicating and drawing. This study showed that employing guided-inquiry methods to teaching helped students to investigate problems and also learn how to use scientific method to solve a problem. The study method employed had added benefit of giving students the chance to develop their science process skills. The implications of the results of the study for teaching and learning science are that the guided inquiry method makes the science classroom more real as students are actively involved in all activities prescribed by the teacher.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter consists of the background to the study, statement of the problem, objectives and research questions, significance of the study, the scope of the study limitations, organisation of the study and purpose of the study.

1.1 Background of the study

The difficulties in teaching are in creating experiences that engage students and encourage their thinking, explanation, assessment, communication, and application of the scientific models required to make sense of these experiences (Afolabi & Akin-bobola, 2009). The requirement for instructional design that promotes greater comprehension of scientific topics is essential to the advancement of science education (National Research Council [N.R.C], 2000). Interactions with several senior high school science students indicated that students rely too heavily on teachers for knowledge.

Guided inquiry is a teaching approach that involves directing pupils to explore knowledge. Teachers act as facilitators of learning, encouraging pupils to be accountable, and autonomous, and to develop their knowledge of scientific topics. Guided inquiry enables students to become autonomous thinkers who are prepared to take on responsibilities (Polman & Pea, 2001). According to Akinmoyewa (2003), self-learning is an educational method in which students use instructional resources to learn either without instructor interaction or with minimal teacher direction.

According to Nwagbo (2006), if learners are permitted to find links and answers to issues and draw their conclusions, they are better prepared to apply what they have learned in a broader context.

A guided inquiry has a positive impact on students' learning outcomes because they provide students with investigative and reflective skills that can be applied in other subject areas, they build on student background knowledge, motivate independent learning, improve students' mental efficiency, and they help them overcome obstacles, allowing them to gain skills on their own (FitzGerald, 2011).

Furthermore, the guided inquiry method accommodates individual variations while also allowing the learning process to be self-sequenced, goal-directed, and pace-determined, allowing students to develop initiative, confidence, creativity, and creative talents (Akinbobola, 2015).

Based on the above, the Researcher concluded that the guided inquiry method provides students with abilities that enable them to be autonomous, creative, and lifelong learners, which is required to keep up with the contemporary educational trend.

1.2 Statement of the problem

Teaching is a constantly evolving practice where research and studies are being performed to find the best practices. It was observed that most students are unable to answer questions in some selected topics in Physics correctly.

Most of their wrong answers revealed specific misconceptions which need corrections. The teaching of science in senior high schools generally appears to be through lectures, note-taking, chalkboard illustrations, and other teacher-centered methods. These methods do not actively involve the students in the learning and problem-solving processes as they are predominantly passive. It, therefore, appears to inhibit the development of students‘ intuition, initiative, imagination, and creative abilities. There is a need to develop new effective instructional methods such as guided inquiry methods which have been found to improve students‘ academic performance in Physics.

Guided inquiry methods of teaching help students attain application and comprehension levels of cognitive development. This is a meaningful teaching and learning method that engage students in hands-on and mind-on activities that help them to form the logical connection between newly presented topics and their existing knowledge (Myers, Monypenny, & Trevathan, 2012).

This study was conducted to find out the effect of guided inquiry instructional methods on students‘ academic performance in some selected topics in Physics at a senior high level.

1.3 Purpose of the study

This study used the guided inquiry method as an intervention to improve students‘ academic performance in some selected topics in Physics.

1.4 Objectives of the Study

The objectives of the study were to:

1. Determine the effect of the guided inquiry method on students‘ academic performance in some selected topics in Physics.
2. Find out how guided inquiry method when applied impacts academic performances in Physics Students.

3. Determine the effects of the guided inquiry method on students‘ attitudes toward Physics.

1.5 Research Questions

The following research questions underpinned the study:

1. What is the effect of the guided inquiry method on students‘ academic performance in some selected topics in Physics?
2. Will guided inquiry method enable students to improve their academic performances Physics?
3. What effects do guide inquiry methods have on students‘ attitudes toward Physics?

1.6 Significance of the Study

The findings and recommendations of this study may serve as useful guidelines for teachers, students, school administrators, educational Researchers, and curriculum developers. Concerning the teachers, the findings of the study may serve as a guide for them to incooperate guided inquiry method in their teaching processes. To the students, the use of the guided inquiry method would make them disciplined, and able to take initiative and plan their studies. This would enhance students‘ academic performance in-class exercises, tests, assignments, and external examinations in Physics. The students would also acquire lifelong learning skills needed for solving challenges. The study would help educational curriculum designers to place more emphasis on scientific inquiry skills when developing a science curriculum.

1.7 Delimitations

The characteristics selected by the Researcher to define the boundaries of the study are called delimitations (Dusick, 2011). It was further explained by Dusick (2011) that it involves delineating properly the boundaries of the study that is what will be covered and what will not be covered in the study in question. It is a way of trying to bring the problem into sharp focus. Setting delimitations and subsequent justifications help the Researcher to maintain objectivity in the study. It also helps other Researchers reconstruct a study or advance future research on the topic. Delimitation provides the scope within which Researchers conclude their findings and determine a study‘s reliability or external validity. The delimitations are under the control of the Researcher. Delimiting factors include the choice of objectives, the research questions, variables of interest, theoretical perspectives the Researcher adopted, and the population chosen to investigate (Simon & Goes, 2013). In the light of the above, the following are the delimitations of the study: There are several methods of teaching science but the guided inquiry method has been selected based on current practices where the need to be independent to cope with the influx of technological advancement in this modern age. The study was restricted to Wenchi Senior High School in the Brong Ahafo region of Ghana. This was due to the proximity and accessibility of the research subjects and also as a teacher in the school. The study was also restricted to SHS2 students because adequate time is needed to prepare them and monitor their performance with time before they write the final examination. Finally, curriculum content was limited to some selected topics which are activities oriented.

1.8 Limitations

Simon and Goes (2013) point out that, Limitations are potential weaknesses in a research study and are out of the Researcher‘s control. They are the shortcomings, conditions, or influences that cannot be controlled by the Researcher and place restrictions on the methodology and conclusions. Dusick (2011) points out that any assumption the Researcher makes becomes a limitation. Since assumptions are inevitable in empirical studies, the study had some unavoidable limitations. The following limitations can be observed regarding this study: It was assumed that the population is homogenous; hence the sample size was not very large. If this assumption was wrong, then data may not effectively present a large population, and consequently, generalization of the findings over a large population would inappropriate. Also, not all forms of guided inquiry methods were employed in the teaching and learning processes. In this study, there was some minimum guidance provided by the Researcher. Another limitation was related to the absenteeism on the part of some of the students. Some students absented themselves from school due to truancy at the time of intervention and this may affect the richness of the data and the results of the study would equally be affected.

1.9 Organisation of The Study

The research report was organised under five chapters. Chapter one consists, the background, the statement of the problem, objectives, research questions, significance of the study, delimitation, limitation and organisation of the study. Chapter two is the review of related literature. It consists empirical and theoretical review of related literature. Chapter three is the methodology chapter which comprises the research design, population and sample selection, research instruments, methods of data collection and data analysis. Chapter four is the chapter where presentation, analysis and discussion of findings are made. Finally, Chapter five consists brief summary of the study, conclusions and recommendations for further research.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

The chapter examines relevant research on the impact of guided inquiry teaching strategies, which encourage students to learn for academic achievement. Examining the literature helps the Researcher to get an understanding of the quantity of work that has been done in the area of interest (Mahaboobjan, 2010). The ideas of guided inquiry, as well as the advantages and disadvantages connected with them, were among the topics covered in the literature study. Other topics investigated were the role of the instructor, motivation, students' attitudes, and the development of process skills. The theoretical framework and conceptual model of the research were also addressed in more detail in this chapter.

2.1 Teaching Physics

Physics education has been acknowledged to be one of the primary cornerstones for the transformation of the economy and so must be paid appropriate attention. It was as a consequence of the recognition given to Physics in the development of person and the country that it was declared a key subject among the natural sciences and other science related courses in Nigeria education system (Adesoji, 2008). Physics has become a mandatory subject for giving most science focused degrees in technology in the higher institutions and these calls for the requirement of teaching it efficiently (Adesoji, 2008). Physics instruction is expected to be result oriented and can only be accomplished when students are eager and teachers are favourably inclined, employing the right approach and research in educating the students (Adesoji, 2008). Students by nature are interested, they need to be actively engaged in the learning process in which they are continually equipping, testing, speculating, and constructing their own unique construct and knowledge. It is only through personalizing such information that it becomes legitimate, relevant and beneficial to them. In Physics, students need to actively develop their own unique consciousness and meanings (Usman, 2000). To prove this, Usman stated that the brain is not a passive consumer of information and to learn with comprehension, a learner must actively make meaning of what is acquired (Usman, 2006).

2.2 Physics Learning and Retention

Permanent and meaningful learning is the objective of each educational activity. Understanding and retention are the results of meaningful learning when instruction is successful and relevant to the students (Bichi, 2002). Retention is defined as the capacity of one to recall what he has learnt in the later time; it takes place when learning is coded into memory. Thus, suitable coding of incoming learning, or incoming information gives the index that may be accessed; so that retention takes place without extensive search capacity maintains and consequently recalls what we have encountered, or what we have in memory (Oyedokun, 1998).

There are various aspects that effect retention. According to McCormack Johns and Tildesley (2005), everything that supports learning should enhance retention whereas items that contribute to confusion, or interference among learning elements diminishes the speed and efficiency of learning and accelerates amnesia. Interference may occur in numerous ways such as retroactive inhibition, or emotional inhibition. Retroactive inhibition develops when things are learnt, the consequence of that leaning normally appears after a passage time. In the interim interval, many more things are learnt. These interpolated learning interact with the recall of the original information and the interference is known as retroactive inhibition (Dewar, Cowan and Della Sala, 2007).

According to Craik, (2020), retention is based on for which the significant inputs are processed by the brain at a deep level. This model is ascribed to the long-time memory (retention) which is based on our capacity to comprehend semantic information profoundly by linking recall pieces.

Different approaches and tactics have been offered for integrating students in classes and engaging them in active learning (Trowbrigde, 2000; Deboer, 2002;). However, in order for any strategy to be successful, proper lesson preparation is needed. The planning phase comprises explanation of the responsibilities of the instructor and students. Thus, it makes simpler for students to follow the teacher‘s lead and encourages them to engage more in the class and take responsibility for their own learning (Webb, 2009). For these reasons, excellent lesson preparation has a favourable influence on students‘ learning Dudley (2011).

2.3 Instructional Methods in the Teaching of Physics

Different approaches and tactics have been offered for integrating students in classes and engaging them in active learning (Trowbrigde (2000); Deboer, 2002). However, in order for any strategy to be successful, proper lesson preparation is needed. The planning phase comprises explanation of the responsibilities of the instructor and students. Thus, it makes simpler for students to follow the teacher‘s lead and encourages them to engage more in the class and take responsibility for their own learning (Good & Brophy, 1994). For these reasons, excellent lesson preparation has a favourable influence on students‘ learning. (Glenng, 2001).

Many various approaches and tactics have been offered for immersing students in classes and engaging them in active learning (Trowbridge 2000; Deboer, 2002). However, in order for any strategy to be successful, competent lesson preparation is needed. A lesson plan demands teacher to be clear about the sequencing of the activities in the lessons, the purpose and objectives of the lessons, the planning process includes clarification of the responsibilities of the teacher and students. Thus, it becomes simpler for students to follow the teacher‘s content and encourage them to engage more in the class and take responsibility for their own learning (Good & Brophy, 1994). For these reasons, excellent lesson preparation has a favourable influence on students‘ learning (Glenng, 2001). Moreover, according to the above, instructors should offer some freedom in lesson design in order to encourage students to engage more in the sessions. A tight lesson plan possibly limits active learning by limiting students from being engaged in the class. Other tactics and approaches include;

2.3.1 Role-playing

This may also be a beneficial teaching and learning exercise to inspire students to engage more in the courses and enhance their comprehension. In role playing strategy, pupils are given an opportunity to perform the position of instructor. It is a theatrical technique. However, study note that role-playing in scientific lectures is underestimated and under-used, sometimes because of misperception about what role-play is and how it might be put to use in science education (Marsh 2010). The Researcher pointed out that the idea underpinning the use of role-play in scientific teaching and learning encourages ‗active', ‗experimental' or ‗student-centred' learning.

Therefore, students are encouraged to be physically and intellectually active in their courses to enable them to both express themselves in a scientific setting and gain a knowledge of challenging ideas. In role-playing approach, the instructor teaches the subject and the students one by one teaches the same topic to the class. They write down the flaws of the student- instructor. This instruction is subsequently critiqued and recommendations for improvement are made. The subject instructor is suggested to be present in the class at the time of role play. He should be present in the class at the moment of critique. The subject of instruction for the purpose of role playing should be the same for all the purposes of comparison. The notion of this approach of teaching is that a group of learners may contribute more ideas than a single individual. Problem may be investigated and appraised more fully.

2.3.2 Cooperative learning

Another teaching technique which gives opportunity for students to build abilities in group interactions and interacting with others which is important in today‘s environment (Castronova, 2002). According to Johnson, Johnson, and Smith, (2007), cooperative learning experiences increase favourable attitude towards the instructional experience than competitive or individualistic techniques. Ibrahim (2006) thinks that students are more likely to develop critical thinking ability and meta-cognitive learning methods, such as learning how to learn, in small group cooperative situations as compared to lectures. Kukulska- Hulme, and Viberg (2018) outline numerous instances in which cooperative learning helps to establish an atmosphere where students are more motivated to challenge the ideas that look obscure to them.

2.3.3 Active learning

Active learning (AL) approaches involves group projects with class engagement and hand on experiment. Other teaching tactics include interactive multimedia (IMM) which is a relatively recent educational breakthrough. It is utilized at elementary, secondary and tertiary level. Interactive multimedia is defined as a powerful combination of early technologies that constitutes an extraordinary advancement in the capability of machine to assists the educational process (Gopalan, Bakar, and Zulkifli, 2017). Interactive multimedia combines computer hardware, software and peripheral equipment to provide a rich mixture of text, graphics, and sound animation to students.

The premise that multimedia information enhances learning process has led to an increased usage of IMM computer aided training (Petty, 2013). The interaction character of multimedia makes it particularly interesting in youth education since interactive allows youngsters to take an active participation in learning process (Ferri, Grifoni and Guzzo, 2020). Research suggests that youngsters are considerably more attention to programming when animation and story are employed (Tang, Yang, Leve, and Harold, 2012). Inquiry style of teaching permits students to engage with the learning materials and the students are accountable for their own learning.

2.3.4 Traditional Method

The conventional approach is an oral (lecture) form of teaching, (Bimbola, 2010). It is primarily a one-way method of transfer of knowledge with the lecturer/teacher being active while the learners remain passive. The modern Nigerian classroom weather elementary, secondary or tertiary institutions level tends to resemble a one- person performance with a captain but often comatose audience. Classes are frequently led by ―teacher- talk" and rely significantly on texts for the framework of the course.

Lecture technique is the most often utilized approach in teaching. However, presentation of speaker without stopping for interaction with students might be unproductive regardless of the quality of the lecturer (Donald, 2000). The traditional method according to Glass, et al (2007) is described as a teaching strategy in which one person generally offers a spoken discourse on a specific topic.

According to Nevid (2021), the scientific instructor arrives to the class filled with a mass of data, he offers ideas or concepts, develops and assess them and summarizes the major points at the end while the students listens and jot down notes. He also discovered that kids just (absorb and absorb" scientific knowledge and factual recollection of specific facts. Brophy (2003) reinforces that instructors have only taken to notes copying strategies after speaking, this approach at best stress the cognitive part of instruction alone. The conventional method of scientific instruction dominates Physics classrooms. Studies by Bichi (2002) confirmed to the fact that most science instructors nowadays in Nigeria utilize the conventional technique. The traditional expository method which is an old aged long traditional method of teaching in which knowledge or information are presented, conveyed or transferred to learners by the teachers who dominates the authoritarian teaching- learning process, talks as an autocrat, as a repository of knowledge to passive listening students who unquestionably see the teacher‘s presentation as sacrosanct. The expectation is that the latter should be able on demand to repeat a role- memory stored knowledge presentation by the instructor (Mezieobiet, 2008). Traditional technique is characterized by a big class size which may vary from 25-100. It is widely used for high secondary school students and postsecondary schools. It has the following characteristics:

i. The pupils are entirely passive listeners and passively digesting knowledge presented to them by the lecturers.
ii. It may be accompanied by visual aids, videos, lecture media and hand-outs. Students are responsible for creating their own notes.
iii. It is teacher-centred; the instructor or the lecturer undertakes the key actions that is talking, illustrating or presenting the films, or other aids (Colburn, 2000).
iv. Traditional instruction is totally teacher- focused.

In this paradigm, teacher is authoritative person and students are the passive consumers of knowledge (Lecture, demonstration, Socratic and so on.) pupils are expected blindly to accept the information they are provided without challenging the instructor (Felder & Brent, 2004). The instructor strives to impart thinking and meaning to passive pupils providing little possibility for student generated inquiries, autonomous thought or interaction amongst students (Friesen & Scott, 2013). Even the laboratory activities which are inclusive in Physics that is frequently done in a group, the conventional instructor evade conversation or investigation of the topics involved. The conventional manner of presentation has this benefit. It saves time and energy in that the instructors cover a significant number of content (syllabus) to a large class size in a very short timeframe. This is also a drawback to kids learning in that only one sense organ is engaged in learning. The benefits of lecture approach according to Oladapo (2008) include the following:

i. It saves time and energy. It is not costly since just the chalk is needed. Good Command of language and aggressiveness saves the instructor a lot of difficulties in the lesson.

ii. It allows simple covering of curriculum and speedier distribution of scientific knowledge and facts.

iii. It provides simple managing of huge courses without much stress. The pupils are taught the same marital material at the same time, that is, there is consistency in the data the students are given.

iv. The student‘s efforts in seeking for information in books are spared as they are provided the facts by the professors.

Disadvantages

The drawbacks as pointed out by Spackman and Yanchar (2014) are as follows: Meaningful learning of science is never emphasized since it appeals to just sense of hearing. The diverse ability groups present in any particular class are not taking care of those pupils who would learn better by touching and manipulating of items are entirely left out. This may be challenging for this set of pupils. It is hard for pupils to sit for a long period at once listening and writing. It might lead to restlessness and disruption of usual class processes. Traditional technique supports simply role learning without essential helping comprehension. The pupils are docile and spoon-fed. It is teacher – focused.

2.3.5 Guided Inquiry

A guided Inquiry teaching technique centres on students learning via ‗hands-on minds-on‘ activities. Instructional techniques having been proved to be beneficial for enhancing student performance in science include active learning strategies. Some of these tactics include inquiry method, conventional (lecture) method, and problem-solving approach, cooperative learning and project method among others.

Guided Inquiry teaching technique has been defined as problem solving, critical thinking, reflective inquiry, deductive reasoning and not just personal assumptions. It is a way of teaching that entails probing, finding out, exploring, analysing, synthesizing, discovering, assessing, questioning and thinking. Guided inquiry teaching technique enables students/pupils to participate in experiments comparable to that of genuine scientists. Through these activities of inquiry, instructors may encourage their students to enhance their critical thinking abilities and utilize their reasoning to deduce solutions to scientific quandaries.

Teaching approaches such as inquiry teaching, issue solving, problem-based learning and project-based learning depends significantly on the successful application of the scientific process skills by students to finish an investigation (Colley, 2006). The approach is founded on the notion that the topic is to be learned actively by completely engaging in the learning process. It is a way that leads to successful learning result that is relevant to the learner . For the students to genuinely participate in an inquiry there is need for the instructor to actually include the students from the planning stage to the evaluation stage. This might be done or attained by the students and the instructor in researching and acquiring knowledge from different sources including reading materials, specimens and community resources.

From a scientific standpoint, inquiry-based science instruction involves students in the exploratory aspect of science. Inquiry incorporates activities and abilities, but the emphasis is on the active pursuit for information or understanding to satisfy a curiosity. According to Ketpichainarong (2009), inquiry teaching and learning approaches impact student‘s performance, for example in solving issues, reflecting on their work, drawing conclusions, and creating prediction. These attributes are required for high- performing kids. Inquiry teaching approach is one means of making meaning out of what we encountered and consequently involves thinking, (Pedaste, et al, 2015). This indicates that the approach entails placing learners into a scenario in which they must be engaged in intellectual process that comprises finding out.

Webb, (2009), described an inquiry teaching approach as a style of teaching where students study concepts, current problems, and probe and question them freely, and practice on their own or with minimal supervision from the instructor. Here, the pupils hunt for knowledge to answer or solve their concerns. Therefore, inquiry teaching is educational and exploratory and provides a lot of pleasure and excitement as students learn by doing. When children are involved in completing particular activities, it simply means that their hands are on the activities, the sort of activities where they are manipulating, observing, investigating, and thinking about science using physical items. Therefore, instructors, regardless of grade level, should encourage inquiry-based education and offer classroom conditions and experiences that enhance students‘ learning of science.

An old Japanese saying goes; ―give a guy a fish and he will not be hungry for a day, teach a man how to fish, he will not be hungry for a life, (Allen, and Tanner, 2005) . By this proverb, it suggests that teaching people how to handle and solve issues by themselves become an asset which is what the inquiry approach stands for, while addressing problems for people, which is what conventional lecture technique is renowned for, is transitory. Scientific enquiry is a strong means of comprehending scientific topics. Students learn how to ask questions and utilize evidence to answer them. In the process of learning the techniques of scientific inquiry, students learn to conduct an investigation and gather evidence from a range of sources, build an explanation from the facts, then explain and defend their results. The application of inquiry technique will assist to guarantee that students gain a comprehensive grasp of science and scientific inquiry (Gilbert, 2011). Teaching Physics via inquiry is not simply giving hands-on activities for pupils, it is more. It is developing experiments and talking about it. It is reporting on their findings, reflecting, and developing and conveying self-assessment. This separation of hands-on activities and student directed inquiries with discourse makes inquiry learning much more than hands-on science (Warfa, et al 2014). Although, the inquiry teaching technique has been characterized by many educationists as successful approach, it is not without certain limitations and many individuals have stated one thing or another against the inquiry teaching method. One of such critics are Prince and Felder (2006) who pointed out various limitations of inquiry technique to include its time demanding character. Much time is required to arrange inquiry activities. It may not be viable to utilize the inquiry technique in all scenarios and some writers like Agboola and Oloyede (2007) claimed that, inquiry approach is more ideal for ―intuitive and creative youngsters who are full of passion and active". Gamble (2010) in his own assessment about the competence of the instructor, stated; ―if the approach is employed by a qualified teacher, it has great lot to give but if used incompetently as fashion, it is probably more catastrophic to learning than sole reliance of the prior ways.

In light of the opinions expressed by these authors, the Researcher came to the conclusion that Guided Inquiry enables students to take the initiative in their own learning experiences. Teacher as facilitator or resource person whose job is to advise and encourage students while also stimulating them to clarify and explain their thinking. The teacher also facilitates the process through which students may mutually agree on objectives. The premise is that pupils are more likely to retain ideas that they find on their own than those that are pushed upon them by their teachers. In a nutshell, the Researcher defined guide inquiry as an instructional method based on leading questions and problem-forming that guides students to obtain knowledge, relationships and concepts by becoming involved in the classroom interaction where the Researcher assists them in becoming more active and more responsible for their learning, rather than passive recipients of the information.

2.3.6 Features of Guided inquiry

According to Westwood (2008), the following characteristics of guided inquiry exist. Among them are the following: students are expected to research a subject or issue using active methods, collect relevant information, evaluate causes and consequences, and reach conclusions. This method is more successful when the procedure is meticulously planned and when students possess the necessary knowledge and abilities on the subject matter being addressed. Various instruments aid in the process of guided inquiry. As described by Westwood (2000), one of the techniques available is simulation. Simulation, according to Westwood, takes place when a teacher offers pupils examples and suggestions that assist them in comprehending particular ideas. One of the characteristics of guided inquiry identified by Reichert (2005) is the use of scaffolds. According to Reichert (2005), scaffolds are the essential assistance and direction given by the instructor to the students while they participate in learning activities in order to arrive at the inquiry, which is expressed as conclusions and principles in the final product.

According to Mayer (2004), the guided inquiry may be a highly time-consuming approach, with knowledge acquisition frequently taking considerably longer than it would with direct instruction to occur. It is explained by Jo (2010) that the inquiry technique does not always work. It may not be advisable depending on the size of the class, the ages of the pupils, or the quantity of information that has to be taught. Although it is true that the inquiry method can ignite students' enthusiasm for mathematics and science in a way that no other method can, Jo (2010) also believes that it can also provide them with the confidence and the power to independently discover, question, analyze, and conquer new ideas if the conditions are right. As a result, he recommends that materials be meticulously prepared in advance and closely supervised to ensure that pandemonium does not ensue when pupils begin to explore the desired information.

2.3.7 The Importance of Questions in Guided inquiry science Lesson

As Dillon (2000) points out, guided inquiry allows instructors to use excellent coaching skills as they identify the most effective methods of guiding students to comprehend or apply new information in situations where the primary instruments of evaluation are questioning. As a result, the purpose of questions is not to test students, but rather to lead them through the course and draw their attention to the most essential topics. Specifically, Kidman (2001) points out that the instructor poses questions that demand the pupils to think, read, research, contemplate and reason in order to answer them.

According to Kidman (2001), when the pupils react, the instructor builds on the idea, develops it more, enlarges it, and provides an illustration. Using questions, the instructor is responsible for keeping the class on track toward meeting the particular goals of the session. In their study, Walsh and Sattes (2005) found that questioning in the classroom had a beneficial impact on student-teacher interaction. It was stated that questioning is the entrance point into issue formulation in inquiry and that it helps to foster participatory learning, strong communication skills, and confidence building in students' learning processes over the course of the course. Educators, according to Thornbury (2004), must be skilled in the art of asking relevant questions to students. This will provide students with the chance to practice problem-solving skills and will assist them in becoming more competent in addressing issues that may occur throughout learning activities. The inclusion of both low-order and high-order questions during learning sessions, according to Thornbury (2004), is essential because high-order questions offer students with additional possibilities for self-evaluation. Getting students to participate in scientific lessons by encouraging them to answer questions or ask questions is, in his opinion, an effective approach for engaging them. This would then assist the instructor in resolving misunderstandings and improving comprehension.

On the basis of the above, it is essential to conclude that leading questions are vital because they activate and keep pupils awake all the time, and check and provide feedback, all of which contribute to the development of new information.

2.3.8 Teachers' Role in Guided inquiry

Nowadays, many individuals believe that the teaching and learning process should be focused on the students' needs. Despite this, the teacher continues to play an important part in the process of interactions, whether it is between the instructor and the students, between students themselves, or between the students and the classroom environment. Several Researchers, including Hardy, Jonen, Moller, and Stern (2006), assert that pupils often hold misconceptions (false prior ideas they have about something) and are unaware that they do so. It is the teacher's responsibility to draw them out and make them apparent to the class. According to Hardy et al, (2006), without supervision, students will be unable to connect their inquiry activity to their misunderstanding and would thus quit. Clarifying ideas in a scientific lecture is very important for student comprehension. According to them, if the instructor does not provide direction to the pupils throughout the exercise, they may come up with an incorrect solution to the issue.

A small percentage of the class are pupils who are totally befuddled and have no previous information or misunderstandings about the specific topic that they are required to learn. According to Mayer (2004), a teacher may engage students' attention by allowing them to participate in the decision-making process about the goal of the activity. A class discussion on the goal of guided inquiry activities, which is properly supported by the instructor, may produce amazing outcomes. It is essential opinion to create an environment where pupils may function and to present them with an end in mind or a purpose for their work (Mayer, 2004).

According to him, as long as the goal remains intact, the students' curiosity will be sufficiently piqued to keep them engaged throughout the inquiry process.

In light of the above, it will be informative to summarize the function of the instructor as follows: explaining incorrect ideas for the students, structuring effectively activities and questions that drive students to inquiry, and providing essential support and assistance to the students.

2.4 Science Process Skills for Students

According to Bilgin (2006), science process skills are very essential for meaningful learning, since learning occurs throughout one's life and people are required to locate, analyze, and assess data under a variety of circumstances. Consequently, Bilgin (2006) believes that it is important for students to be taught scientific process skills at educational institutions. Science process skills provide the conceptual foundation for scientific inquiry, according to Saat (2004), and include the capacity to organize and characterize natural things and occurrences. Science process skills are sometimes referred to as foundational abilities in scientific inquiry. Observing, categorizing, measuring, and forecasting are some instances of science process skills, according to him. Following on from this, Saat (2004) asserts that the Science process skills are prerequisites to the integrated process skills and that the integrated science process skills are terminal skills necessary for addressing issues or conducting scientific investigations. According to the author, some examples of integrated process skills include identifying and defining variables, collecting and transforming data, constructing tables and graphs of data, manipulating material, describing relationships between variables, interpreting data, formulating hypotheses, designing and conducting investigations, drawing conclusions, and generalizing. According to Colley (2006), when scientists plan and carry out experiments in daily life, the fundamental skills are integrated together, and all of the basic abilities are essential both separately and when they are integrated together. According to Colley (2006), science process skills serve as the foundation for the scientific method, and there are a variety of instructional approaches that science educators and teachers can use to help students acquire process skills, including activity-based, problem-based, and project-based approaches. The focus on student-directed learning rather than teacher-directed learning, active learning rather than passive learning, and integration of information and process rather than separation of content and process are all quite similar, in his opinion, to other instructional methods. A second finding by Taraban (2007) is that an active learning and teaching approach, as opposed to a conventional strategy, offers advantages in learning and teaching science, both in terms of scientific content and in terms of the development\``` of procedure skills. Hands-on, mind-on exercises that assist students to develop process skills, according to him, are examples of active teaching and learning methods.

2.5 Students' Attitudes to science

When it comes to attitudes toward science and mathematics Mogari (2003) cites Aiken (2003) as saying that attitude is a composite character that is composed of the following personality factors: motivation, pleasure, value, and fearlessness of science and mathematics. He implies that attitudes are reinforced by beliefs (the cognitive component), which in turn attract strong emotions (the emotional component), which in turn lead to a specific type of behaviour (the behavioural component) (the action tendency component). In this research, attitude relates to students' motivation (encouragement), interest (enjoyment), involvement, and interpersonal connection with science instructors when it comes to learning about scientific concepts and theories. Ellington (2003), argues that one's attitude may be seen as either good or negative.

Moreover, according to him, a good attitude toward science reflects a positive emotional disposition for the topic, and in a similar vein, a negative attitude toward science indicates a negative emotional disposition toward the subject. According to him, these emotional dispositions affect an individual's behaviour, since one is more likely to accomplish greater results in a topic that one loves, has confidence in, or finds helpful. Ellington (2003) insists that having a good attitude toward science is beneficial since it affects one's desire to study as well as the advantages that may be derived from scientific education, according to the author. It has been pointed out by Hannula (2002) that views may shift in a short period, and some cases, drastically. Several Researchers, including Hannula (2002), have shown that many students' attitudes about a specific topic, particularly younger and less established students are inversely related to their recent performance in class. He asserts that having a good day may influence one's attitude in a positive manner while having a terrible day can have the opposite effect and influence one's attitude in a negative way. Udousoro (2002) found similar findings after exposing students to computer and text-aided programmed teaching, while Popoola (2002) obtained similar results after exposing students to a self-learning device.

From the above reasons, it is possible to conclude that students' attitudes toward science (Physics) at the secondary school level have a direct relationship with their learning and performance. Consequently, all stakeholders in education (parents, instructors, and others) must work together to help children acquire a favourable attitude toward the study of scientific concepts and procedures. In order to assist students to obtain better outcomes in the study of Physics, it is important to acknowledge that establishing an enabling atmosphere is a critical element in the formation of positive attitudes in students. The culture as a whole must have a favourable attitude toward science, which will assist youngsters in developing a highly positive attitude toward science even before they begin school.

2.6 Concept of Performance

Performance evaluation is the direct, systematic observation of an actual student's performance and grading of that performance according to the pre-established performance criteria (Angyaye, 2007). Students, when asked to do a hard activity or develop a product, they are judged on both the product and the final result of their effort. Many performance tests contain real world activity that asks for higher order thinking (Angyaye 2007). The performance-oriented approach to education allows students to utilize their knowledge and apply skills in genuine circumstances. It varies from the conventional approach to education in that it seeks for mastery of information and abilities; it also assesses them in the context of practical work. Furthermore performance- oriented education focuses on the process student's travel throughout the learning process (Tam, 2014). In addition, performance- oriented education supports the development of other crucial component of learning namely the emotive, social and meta-cognitive element of learning (Tilley, 2005)

Performance- oriented education stimulates students to engage in exciting and relevant activities. It helps pupils build a feeling of pride in their work, encouraging confidence in the target language. The evaluation therefore allows students to show particular abilities and competence by doing or creating something. Through performance- oriented education, instructors may track students, work on a task, show them the importance of their work processes and assist monitor them to utilize such like periodic reflections working files and learning logs more effectively (Adesokan, 2002). The following are some of the benefits of performance evaluation on pupils by (Adesokan, 2002):

i. It develops problem solving and critical thinking skills

ii. It stimulates diverse thinking

iii. It focuses on both product and process

iv. It fosters individual learning through planning, reviewing and summing

v. It draws on pupils' past experience

vi. It may offer chances for peer interaction and collaborative learning vii. It promotes self-assessment and reflection

vii. It is intriguing, challenging meaningful and genuine

viii. It needs time to accomplish.

A prolonged performance challenge may grow into a project; following definition of project derived from Lazonder and Harmsen (2016). A project is a lengthy and difficult performance endeavour, generally occurring over a period of time. Projects normally entail substantial student's investigation cumulating student's product performance which is affirmed utilizing a range of evaluation approaches.

Performance oriented teaching and evaluation requires instructors to define the information the learner needs to gain and how it may be applied from the beginning of the planning process (Raimi 2002). A fundamental distinction between adopting performance-based assessment and conventional testing is that under a performance-based approach, evaluation happens throughout the teaching/learning process. The teacher unit's plans must explain how each of the instructional objectives is assed in the unit. With the curriculum, instructors determine the major bench mark in the many domains and the pre-requisite knowledge and abilities necessary to execute this bench marks. At this level, the proper evaluation technique has to be linked to each objective and should evaluate child achievement (Raimi 2002).

2.6.1 Academic Performance in Physics

Academic performance is defined as the measure of what a person has attained following exposure to educational activities. In study performed by Chen and Yang (2019) on the impact of inquiry method and the key advantages of inquiry approach, he reveals that students exposed to inquiry instructional technique scored better than those students who were taught the same topic using subject matter approach. Ramanathan, Carter, and Wenner (2022) performed a meta-analysis of the influence of inquiry linked curricular on the students' performance and concluded that the curriculum Enhanced students' scientific accomplishment via inquiry.

Recent science education standards stated that all students should learn about both scientific inquiry and learn science via inquiry (Donat, Brandtweiner and Kerschbaum, 2009). However, several prior investigations have indicated that an inquiry-based education style may boost students' science-process skills concept acquisition and accomplishment in Physics.

2.6.2 Students Attitudes and Performance in Physics

Students' success in Physics relies on numerous aspects and stands out to illustrate how well a student is performing. Festus (2007), believe that performance looks usually to be the primary objective behind every life struggle, but the positive platform has consequential consequences of boosting the worth of the pupils and can only be reached via development of positive learning attitudes. The attitudes of a pupil trigger his actions. Attitudes are antecedents which serve as inputs or cues that activate actions.

Attitude is an emotional attitude of somebody towards an item or event. Fisher (2010), view attitude as a predisposition of a person to react in a specific manner to a stimulus. Navarro, et al (2016) defines attitude as a specific emotion about an item or thing and consequently entails a predisposition to act positively or negatively in scenarios that involves a tendency to behave positively or negatively in situations that involve the object or thing. From the preceding definition, it demonstrates that an attitude is oriented toward something and this may be a human, school policy issue or even ideas or any tangible item. Jomaa, McDonnell, and Probart (2011) in their investigations revealed that students' good attitudes to science correspond substantially with their scientific proficiency. In order to answer Physics issues in an appropriate way, the problem solver must have both conceptual scientific and procedural knowledge (Ekpete, 2002).

Bichi (2002), have observed that male and female students typically have no variations in their results if they are exposed to problem solving approach. With Particular regard to integrated science, (Ugwu and Soyibo, 2004). discovered no significant gender disparities in Jamaican 11th graders' performance in integrated science. However, several research demonstrated that pupils typically do not employ conceptual knowledge in solving Physics issues. These investigations also provided evidence that students were restricted in their capacity to address remote transfer issues without an in-depth grasp of key Physics principles. Prince and Felder (2006) argued that Physics educators and instructors have frequently considered that success in solving Physics problems should demonstrate knowledge of the science topics. According to Greenwald (2002), the greatest approach for kids to learn Physics is to encounter tough issues and the ideas and actions connected with solving them. Gunasinghe, et al (2019) indicated that the inquiry-oriented education style created much higher favourable views towards the subject matter among science students than did the standard lecture method. They also noted that the inquiry teaching style considerably boosts good attitudes towards science among group involvement. Mansour (2009) also studies the link between teaching technique and attitude of students and discovered that inquiry approach is more motivating than standard lecture method.

Attitudes of Students towards Physics and Instructional Method

Sola and Ojo (2007) defined attitude as ideas and views that might incline somebody to act in specific ways. Attitude may be considered as to contain both cognitive and effective component, attitudes are supposed to impact future behaviour and have consequences for such things as learning. Prince, and Felder (2006) demonstrated that both cognitive and emotional attitudes were important determinants of commitment to the application of learning. Rutten, Van Joolingen, and Van Der Veen (2012) demonstrated that the inquiry-oriented education style created much more favourable attitudes towards the subject matter among scientific students than did the standard lecture method. They also mentioned that the inquiry teaching style greatly boost good attitudes towards science among group involvement. Kimoto (2015) also studied the link between teaching technique and attitude of students and discovered that inquiry approach is more motivating than standard lecture method. Osborne, Simon and Collins (2003) evaluated the impact of inquiry teaching style on geological achievement and students' attitudes towards science. He suggested that inquiry teaching style boosted academic success and strengthened the students' attitude towards science.

2.6.3 Factors Affecting Students' Performance in Physics

Despite the key place Physics holds in our educational system and effort made by Researchers to boost performance, students' Physics performance in general is still poor (Turri, 2017). Some of the factors suggested for this failure include laboratory inadequacies, teacher‘s attitude, examination misconduct, lack professionalism and atmosphere. Science practical in schools is intended at offering the students the chance to receive relevant learning, acquire necessary skills and attitude that lets them live and contribute to the growth of the society (Lawrence & Abraham, 2011).

In view of the above factors suspected to be some of the reasons why students‘ performance in Physics continue to decline, a study conducted by Lawrence and Abraham (2011), investigated the low achievement in Physics within some selected schools in Zaria Local Government ranging from teachers variables (attitude, qualification, attendance at Physics workshop, condition of service), student variable (class of career, attitude) and environmental related variable (class size, school location and laboratory adequacy) showed that most teachers in the teaching professions are not thereby choice, rather by accident, they consider it to be a waiting ground for better jobs. Such professors have little enthusiasm in teaching. Under student‘s attitude towards Physics, most students perceive it to be a tough topic, and consequently, the love for studying continues to drop. Under instructor variable, non-professionalism is also a huge concern since some teachers are teaching Physics but are not graduates of Physics. Also under environmental factors, at certain schools when students‘ population is enormous, the classes are split into sets. (For example, Set1, set2 …and so on) with two contacts of 40 minutes every week however in other schools it is four contacts of 40minutes for other days and 35 minutes every Fridays. When questioned whether it is feasible for them to cover their curriculum before the students face their external exams, majority had to respond it‘s not possible. Other elements impacting student‘s success in Physics include:

Class size: Some professors were questioned to what degree the size of their classrooms impacts their teaching. Most teach a huge class with many pupils and some others despite the fact that a class is large opt to teach three courses.

Condition for service/compensation: Inadequate remuneration and poor staff welfare has damaged the morals of most teachers. Most of them are salary concerned and tend to look down on the payment for service.

Laboratory adequacy: Physics is a topic that takes a lot of demonstration and can only be properly taught for simple access to instrumental materials, although most schools lack key qualities/facilities. Most of the schools do not have a laboratory or even if they do, most of them are not adequately equipped.

Examination malpractice: one of the professors observed that most of the students chose to relax because of what would come out of their teachers and parents. Some of the instructors remarked that examination malpractice influences the kids to a very big amount, the student, teachers, parents and invigilators are all engaged.

Choice of career: Others kids are not into sciences by their own personal choice, some are into it because of their parents, and supervision, and so on who demand they must be scientific students.

From the criteria described above, it can be recognized that the teaching profession has been reduced to transit work. People do not have enthusiasm for teaching and such attitude shows in the manner they teach this topic which has poor impacts on student‘s performance. It is also obvious that student‘s bad attitude towards Physics is what is linked to the poor performance that is witnessed nowadays (Boase, et al. 2017). Time restrictions is one of the primary causes responsible for poor performance and is also one of the reasons why curriculum is not completed as scientific practicals are not done (Adesokan, 2002). The study of Lawrence and Abraham (2011) also implies that students would have fared better if exposed to a Physics practical lesson in good time, student tend to also grasp and retain what they see more than what they hear as a consequence of utilising labs in the teaching of science. On the impact of test misconduct, it was revealed that it has done so much damage than benefit to student performance not only in Physics but also in general scientific topic. It is obvious that students who did not learn cannot perform and since examination is still the common index for measuring performance especially in our society, passing has become a do or die affair such that a teacher who did not do his work well probably because of lack of time but want to please the school and the parents, indulge in examination malpractice and the students end up coming out colourful but with no knowledge of the subject (Lawrence and Abraham, 2011). The children are aware that even if they are not serious and properly instructed, they will still be compelled to pass at the end by their parents or instructors.

2.6.4 Reasoning and thinking Condition for Better Performance in Physics

Reasoning and thinking condition is a form of logical and reflective thinking that is aimed at determining what to believe or what to do. It is a means of judging if a proposition is always true, sometimes true, partially true or untrue (Kivunja, 2014). Critical thinking may be traced in western philosophy to the caustic approach of ancient Greece and in the east to the Buddhist Kalama sutra. Critical thinking is a crucial component of numerous professions including Physics. It is part of formal education process through graduate‘s education (Brookfield, 2000).

The list of essential critical thinking in Physics comprises observation, interpretation, analysis, interference, evaluation, explanation and cognition. There is a considerable degree of agreement among experts that a person or group engaged in strong critical thinking pays appropriate attention to establish:

i. Evidence via observation
ii. Context
iii. Relevant factors for making the proper judgment
iv. Applicable procedures or approaches for formulating the judgment
v. Applicable theoretical concept for comprehending the situation and the topic at hand.

To process good critical thinking abilities one must be oriented to engage challenges and choices utilizing such skills. Critical thinking utilizes not just logic but broad intellectual standards such as clarity, credibility, correctness, precautions, relevance, depth, breath, importance and fairness (Musingafi,& Muranda, 2014).

2.7 The constructivism theory developed by John Dewey

The philosophy of constructivism is concerned with how we come to know what we know. Constructivism theory is based on the premise that children, adolescents, and even adults construct or make meaning about the world around them based on the context of their existing knowledge (Llewellyn, 2005). It provides a framework through which emerging ideas about teaching, learning, and assessment can be unified. In this theory, the difficulty and challenges facing classroom teachers stem from the fact that reform strategies in curriculum, instruction, and assessment organized around the theory of "constructivism" are informed by different assumptions about the nature of knowledge and the human capacity to learn than traditional classroom practice (Kim, 2005).

Humans create knowledge and meaning from their experiences, according to constructivism, a psychological theory of knowledge that was developed in the 1960s. This idea emphasizes the need to not just accept what you are told, but also consider your previous knowledge of what you are taught and your views of it. In constructivism, the importance of active participation of students is stressed, and as a result, the information acquired remains in their minds for a long time. As Kim (2005) emphasized, human beings are not just passive receivers of knowledge, as was previously thought. Taking information and connecting it to previously absorbed knowledge, learners actively take knowledge and make it their own by creating their own interpretation (Capps Crawford, & Constas, 2012). In accordance with Mahoney (2004), students enter a classroom having their own life experiences and a cognitive structure derived from those experiences. These preconceived frameworks may be correct, invalid, or incomplete, depending on the situation. In order for the learner to reformulate his or her current structures, new information or experiences must be linked to previously learned information or experiences. Students must individually make inferences, elaborate on new concepts, and establish relationships between previous perceptions and new ideas in order for the new notion to become an integrated and functional part of his or her long-term memory. Facts or knowledge that has been memorized but has not been linked to the learner's previous experiences will be rapidly forgotten. Briefly stated, the learner must actively integrate new knowledge into his or her current mental framework in order for effective learning to take place. The inquiry teaching technique is an activity-based teaching approach that engages students in the learning process. It places less focus on transferring information and more emphasis on building students' scientific process abilities, as opposed to traditional teaching methods. This fact leads to the assumption that the inquiry teaching technique, which is an activity-based method, will assist in improved learning in the subject of Physics. Lasker and Weiss, (2003) pointed out that the responsibility for learning should increasingly rest with the learners in situations where they are actively involved in the learning process, as opposed to previous educational viewpoints in which the responsibility for teaching rested with the instructor to impart knowledge. According to constructivism, the teacher's job is to arrange knowledge around conceptual clusters of issues, questions, and discrepant circumstances in order to pique the attention of students. Teachers guide students through the process of gaining new ideas and linking them to their prior knowledge. Ideas are given in a holistic manner as large ideas, and then they are broken down into smaller components.

It is important that students take an active role in the activities, and they are encouraged to ask their own questions, conduct their own experiments, draw their own parallels, and arrive at their own conclusions (Atkinson & Delamont 2017). Cognitive theorists think that the job of the teacher is to give learners with chances and motivations to learn, and they believe that this includes, among other things, providing learners with the following opportunities and incentives:

1. With the exception of rote memory, all learning needs the learners to actively create meaning in order to be successful.
2. Before understandings and ideas about a subject or concept held by students prior to education have a significant impact on what they learn during teaching in that topic or concept.

3. The main aim of the instructor is to bring about a change in the learner's cognitive framework, which is his or her method of seeing and organizing the world.
4. Learning through collaboration with others is a valuable source of inspiration, support, modelling, and coaching for individuals and groups (Darwin 2017).

It is supported by cognitive pedagogy, which asserts that people have an inherent sense of the world, and that this domain enables them to transition from being passive spectators to actively participating in learning activities. The Constructivist approach to teaching emphasizes actively involving students in the learning process, rather than assuming that they will automatically absorb and believe what they read in the textbook and are told in the classroom. Because human beings are not passive recipients of information, as Carlson (2003) believes that identifying, building upon, and modifying existing knowledge (prior knowledge) students bring to the classroom is important.

Traditional instructors are information providers, and the textbook-guided classroom has failed to achieve the intended result of creating critical thinkers among the pupils it has served. One often praised option is to shift the emphasis of the classroom from being controlled by the instructor to being focused on the students. With the guided inquiry approach-based Constructivism, you are not accepting what you are told but rather your previous knowledge and perceptions about what you are taught and how it is presented. Constructivism places a strong emphasis on the active participation of pupils, which allows them to retain information for a long period of time.

Empirical Studies

Research was carried out in Ogun state by Bimbola (2010), on the impact of constructivist-based teaching method on academic performance of students in integrated science at junior secondary school level. A Quasi-experimental research design was employed to perform the investigation. The research comprised 120 junior secondary school pupils in Ijebu-Ode Local Government Area of Ogun State, South-West Nigeria. Findings demonstrated that the constructivist taught students had greater scores on the post test, compared to those exposed to traditional (lecture) way of instruction. It also adds that in a constructivist context, knowledge is not objective, mathematic and sciences are regarded as systems with models that depict how the world may be rather than how it is. The research study proposes that if integrated science instructors could include constructivist-based teaching approach into their teaching techniques, there would be an increase in academic performance of junior high school students in integrated science. It also proposes that students should be permitted to apply what they learn in school to the diverse and unforeseen circumstances they meet in the course of their education. The reviewed work is closely related to the present study in the sense that both studies focused on ―the teaching method on students' performance" however the difference between the two studies is that the former is about the performance of students in integrated science at the junior secondary school level while the latter is on the performance of students in Physics at senior High school.

Sevilay (2004) carried out research on the influence of inquiry-oriented chemistry course on students' grasp of atom idea, learning methodologies, motivation, self-efficacy, and epistemological views. The objective of the research was to evaluate the impact of inquiry-based high school chemistry course and gender differences with regard to students' comprehension of atom idea, learning methodologies, motivating goals, self-efficacy, and epistemological views. Non-equivalent control group design was employed to perform the study. The research tools utilized for the study were named Chemistry Achievement Test (CAT), Learning Approach Questionnaire, Achievement Motivation Questionnaire and Science knowledge Questionnaire instrument. A total of 47 ninth grade chemistry students were utilized as sample for the research. T-test and ANOVA were used to evaluate the data. Research results indicated that the students who utilized the inquiry-based education had considerably higher scores with regard to accomplishment connected to atom idea than the students who were taught using the conventionally constructed chemistry training. The research work is related to the present study in terms of the instructional strategy used but the difference is that, the study by Sevilay is on _Effects of Inquiry Based on students' understanding of atom concept, learning approaches, motivation, self-efficacy, and epistemological beliefs' while the present study is on the Inquiry method on students' Performance in Physics.

Research was also carried out by Wilson, Taylor, Kowalski and Carlson (2009), on the Relative Effects and Equity of Inquiry-Based and Commonplace Science Teaching on Students' Knowledge, Reasoning, and Argumentation. The purpose of the research was to determine if causal inference could be formed regarding the efficacy of inquiry-oriented education. A laboratory-based randomized control strategy was adopted. A sample of 58 students were randomly chosen and utilized for the research. The study instrument consisted a survey and a standardized open-ended interview that includes four multiple choice questions, eight true/false item and five constructed answer items. Data was examined using interclass correlation. This research indicated that students receiving inquiry-based education obtained considerably greater levels of accomplishment than students undergoing commonplace instruction and furthermore, the mean scores for the inquiry-based unit were significantly higher than the mean scores for the commonplace. This research is comparable to the current study in terms of one of its aims (investigating the efficacy of inquiry method as an educational technique) but, it varies in terms of the processes for data collecting and the methods for assessing data.

Ozdileke and Bulunuz (2009) carried out a study effort on ―the Effect of a Guided Inquiry Method on Pre-service Teachers' Science Teaching Self-Efficiency Beliefs. The purpose of the research was to assess the impact of guided inquiry technique for scientific education on primary pre-service teachers' self-efficiency perceptions. A pre-test/post-test one group study design was adopted. The Elementary Science Teaching Efficiency Belief Instrument (STEBI) was completed by the participants. Focus group interview were done with 10 groups of participants. The study's sample comprised of one hundred and one (101) second year pre-service primary teachers. The data were examined by utilizing paired sample t-test with Spss at the 0.01 significant level. Qualitative and quantitative data suggested that levels of participants' efficiency expectations and outcome expectations on post-test scores were greater than the pre-test scores. Also, the usefulness of a guided inquiry strategy to boost the feeling of self-efficacy beliefs of pre-service teachers in scientific instruction was demonstrated. Therefore, the similarities between Ozdileke and Bulunuz's work with the present research work is that both made use of the same research design however both studies differ in instrument used and target population.

A study was carried out by Hussaini, Azeem and shakoor (2011) on Physics Teaching Methods; Scientific inquiry Vs. Traditional Lecture. The major objective of this study was ~~to~~ study the effect of three levels of scientific inquiry method and traditional method of teaching physics on students' performance and their proficiency to apply the physics knowledge in real life situations. The pre-test post-test control group experimental design was used in this research study. Three instruments were used in the study which are; physics proficiency test, students' intelligence test and socio-economic status Performa. 175 male physics students of 10thgrade were chosen and served as sample for the research project. Data were evaluated by utilizing Content alignment analysis. The study work investigated that there is considerable influence of guided, unguided and combination scientific inquiry on students' success than standard physics education method and their competency to apply the principles of physics in actual circumstances. The previous work is comparable to the current research in such that both assessed teaching techniques on students' accomplishment and performance in Physics

Saeed, (2011) carried conducted research on The Effect of Inquiry Method on Achievement of Students in Chemistry at Secondary Level. The key aims of the research were: to find out the relative impacts of inquiry-based education as supplemental approach on the academic success in chemistry and low intelligence. The study made use of an experimental research design paired with a Chemistry Achievement Test (CAT) as instruments for the investigation. 45 senior secondary 111(SS3) students were chosen as sample for the research. Obtained data were evaluated by performing t-test. Findings indicated the superiority of inquiry method. The study is similar to the present study in terms of the teaching method (inquiry method on students' performance) but the difference lies in its objectives.

2.8 Theoretical Framework

As defined by Khan (2010), a theoretical framework for a study is a structural framework that maintains and supports the theory of a research project. The author went on to say that it is used as a lens by Researchers to study a certain element of their subject area. This is something that the Researcher believes is true. According to established theories and empirical facts obtained from credible studies, a good theoretical framework assures the reader that the type of investigation Researchers propose is not based on their personal instincts or educated guesses, but rather on established theories and empirical facts obtained from credible studies (Trochin, 2006). The constructivist theoretical viewpoint served as the foundation for this investigation. Constructionist theory in the classroom is theoretically grounded on the cognitive developmental theories of John Dewey, Jean Piaget, Lev Vygotsky, and Jerome Bruner, which offer a theoretical foundation for its application (Kearsley 2001). It is mainly based on the ideas of Piaget and Vygotsky that the cognitive developmental perspective is held (Bjorklund, 2000). Based on the assumption that when individuals respond to their environment, socio-cognitive conflicts arise, resulting in cognitive instability, Piaget and his colleagues set out to prove their point. This subsequently promotes the capacity to think from a different viewpoint, and therefore cognitive growth (Bjorklund, 2000). He emphasized the importance of cultural and social effects on cognitive development, especially the contact of children with other people, in the development of cognitive abilities (Kearsley 2001). When Vygotsky defined the zone of proximal development, it meant the gap between what children can accomplish on their own and what they can do with a little assistance from their peers, teachers, and parents (Mcleod, 2012). Educator John Dewey felt that children were naturally driven to actively learn and that schooling simply served to provide even more learning opportunities for them (Berding, 2000). According to Kearsely (2001), ―Bruner's constructivist theory is founded on the investigation of cognitive processes." Learning is an active process in which learners build new ideas or concepts based on their present or previous knowledge, according to this notion, which is a significant topic in education. According to Figure 1 below, the Researcher then divided the theoretical framework into four ideas: the teacher's function, the learner's role, resource and materials, and learning.

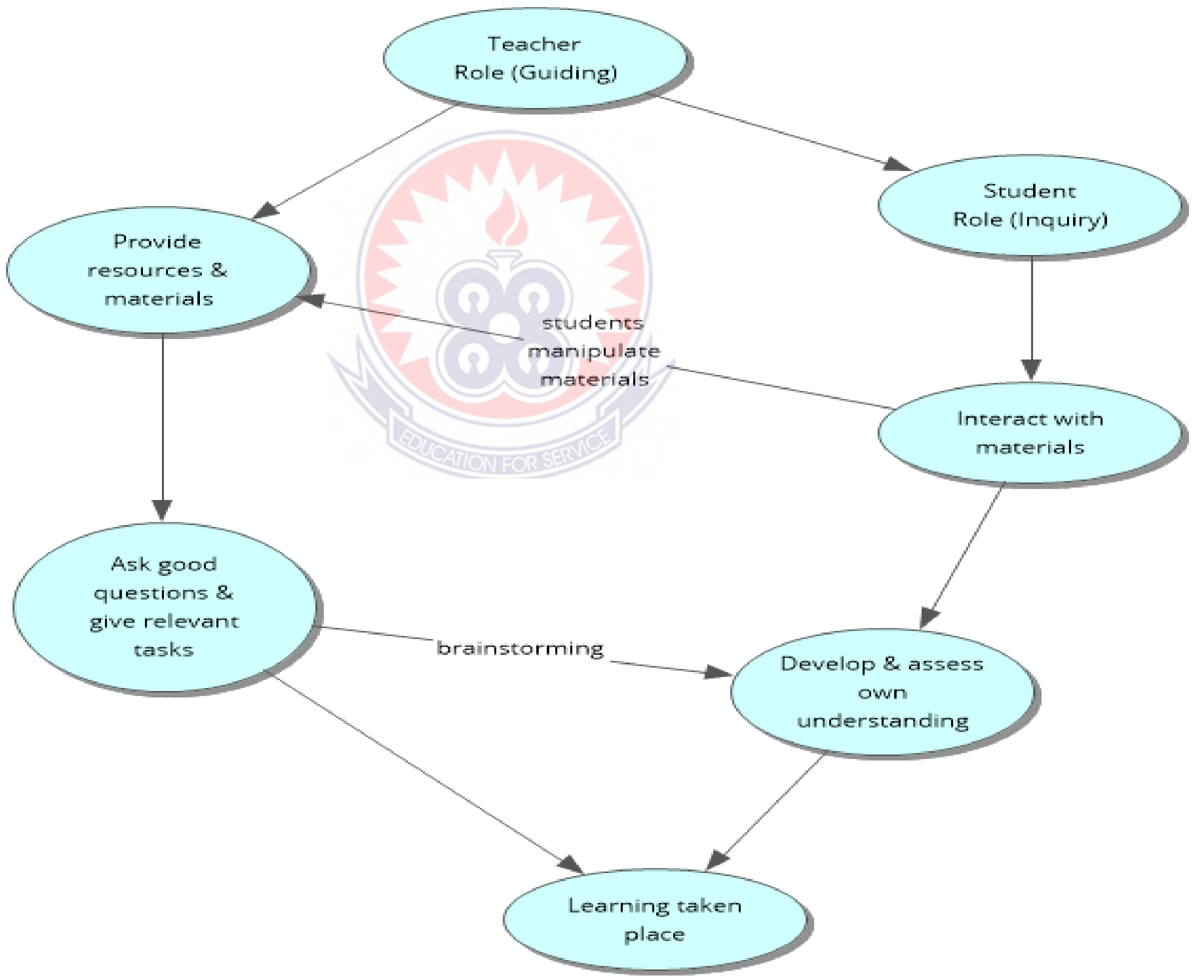


Figure 1:The four concepts that were developed.

In this model, the instructor and the student work together to provide meaningful learning outcomes, the instructor serves as a facilitator, providing educational guides and manipulative tools to the class as needed. Manipulative materials are tangible artefacts that enable students to investigate and discover.

The concept is presented in a hands-on, dynamic manner in such a way that the student adheres to the guidelines provided by the instructors. The learner follows the instructional guides which are the primary source materials and interacts with the manipulative materials and carries out activities. In the process, the instructor asks facilitating questions that excite and assist the student in thinking, as well as being relevant to the task or project. However, students who find the task difficult to do may negotiate with the teacher for change. The learner develops and assesses his or her own understanding and this leads to learning

CHAPTER THREE

METHODOLOGY

3.0 Overview

The research approach used in the study is discussed in detail in this chapter. It explores the many sorts of research designs and argues in favour of the use of an action research design as an alternative.

After that, it went into detail on how the population and sample were chosen, and it described why a certain sampling approach was used in each case. Other topics discussed include the instruments utilized for data collecting, the validity of the research instruments, and the methods used to analyse the data acquired to establish the efficiency of the teaching methodologies that were used.

3.1 Research Design

A comprehensive strategy for gaining answers to the research questions being explored is research design (Airasian, 2000). The study design refers to the precise data analysis techniques or methodologies that the Researcher used throughout the investigation (Fraenkel & Wallen, 2000). A research design is defined as an outline or template that explains how data about a certain topic should be gathered and analysed. Amedahe (2002) went on to clarify that the choice of a particular research design for each research study must be relevant to the issue under examination and that the many research designs possess distinct benefits and drawbacks. Some examples of research designs include surveys, case studies, quasi-experimental studies, and action research or experimental study.

3.1.1 Survey

A survey is a scientific investigation that includes gathering information from a large number of instances, sometimes utilizing a questionnaire, and is often referred to as a scientific study (spent 2010). According to Creswell (2008), surveys are useful for eliciting people's impressions, opinions, and ideas, but they are less trustworthy for determining how individuals behave in the real world. Cepni (2010) categorizes surveys as either cross-sectional (data obtained all at once) or longitudinal (data collected over some time), and he notes that questions of generalization are often raised when survey findings are presented. Moreover, the author explained, because survey design methods enable Researchers to collect data from a large sample in a short period, and because survey method studies are carried out to determine current situations, they prepare the necessary background for case studies to be conducted.

3.1.2 Case Study

This entails gathering information from a single or a limited number of instances, which is usually the case. It generally contains a great deal of information regarding largely qualitative instances. (Seawright & Gerring 2008)

In the case of individual Researchers, the case study technique is useful because it provides the possibility for one element of a topic to be investigated in sufficient detail within a restricted time frame (Seidu, 2007). A case study is often intended to give insight into a specific event, and it frequently emphasizes the experiences and interpretations of individuals who are engaged in the issue. It has the potential to lead to new knowledge, explanations, or hypotheses. Cepni (2010) noted that the most significant strength of this study is that it enables the Researcher to focus on a single instance or circumstance and to discover the many interacting processes that are taking place at the time of the investigation. When conducting a large-scale survey, these processes may go undetected, yet they might be critical to the study's success or failure. However, it does not often assert representativeness and therefore be cautious not to over-generalize in its conclusions.

3.1.3 Quasi-experimental

Quasi-experimental research design is defined as group selection without the use of any random pre-selection techniques before testing a variable in the groups (Shuttleworth, 2008). The following are examples of quasi-experimental research designs: one-group post-test only design; one-group pre-test post-test design; removed-treatment design; case-control design; non-equivalent control groups design; interrupted time-series design; and regression discontinuity design (Shadish, Cook & Campbell, 2002). As described by Shadish, Cook, and Campbell (2002), quasi-experiments are particularly valuable when evaluating the impact of public policy changes, educational interventions, or large-scale health interventions in situations were conducting an experiment or a randomised control trial is not feasible or desirable.

3.1.4 Action Research

Action Research is a kind of research that is carried out in response to a problem. Action research includes systematic observations and data gathering that may be utilized by the practitioner-Researcher in the process of reflection, decision-making, and the creation of more effective instructional practices in the classroom (Parson & Brown, 2002).

The phrases ‗action and research', which are used to connect them, emphasize the important characteristics of this method: Putting ideas into order to gain more understanding about or improve curriculum, teaching, and learning processes (Seidu, 2007). According to Mills (2000), the objective of selecting action research is to bring about good educational change in the classroom. Mills (2000) argues that action research is used to address a specific issue in a particular context to bring about a positive change. This is supported by the literature. According to Labaree (2011), the basics of action research design follow a distinctive cycle in which an exploratory posture is taken at the start of the research process. According to him, this assists the Researcher in learning about and comprehending the situation under examination, allowing him or her to build some kind of intervention approach. According to Labaree (2011), the intervention is carried out during which important observations are taken in a variety of formats to aggregate and analyse data to enhance the overall intervention approach. Through a cycle of preparation, action, observation, and reflection, the technique allows Researchers and their participants to learn from one another (Steeples, 2014). The cyclical nature, according to Steeples (2014), encourages greater knowledge of a particular problem, beginning with conceptualization and progressing through various interventions and evaluations. The cyclical nature of the action research paradigm outlined by Steeples (2014) is shown in Figure 2

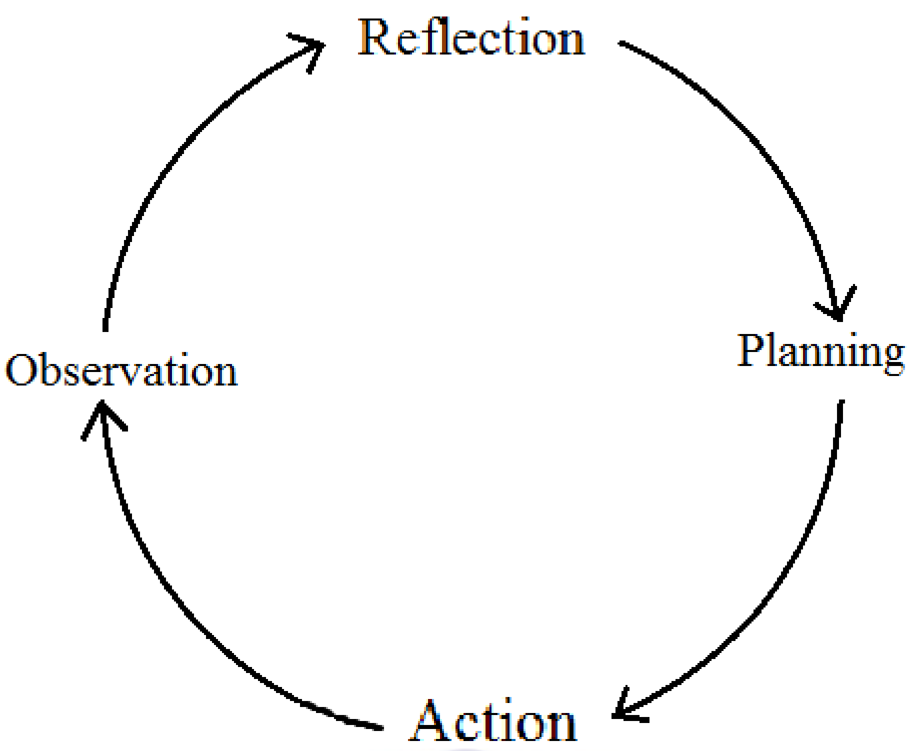


Figure 2: Action Research Model

Among the actions include reviewing one's practice and recognizing an issue or worry, developing an intervention that may remedy the problem, implementing the plan, and lastly assessing the outcome or gathering data. This cycle is repeatedly performed in an attempt to improve the situation until the issue is resolved. According to Ferrance (2000), action research is a disciplined inquiry carried out by a teacher with the purpose that the findings would inform and modify the teacher‘s practices in the future. According to the Researcher, it is an interactive process rather than a one-time exercise in which the teacher transmits information, and that it is most often used when situations necessitate flexibility, the participation of participants of the study, or when modification must occur quickly or comprehensively.

In this research, an action research design was used, and the goal was to identify an instant remedy to students' failure to accurately answer questions in certain chosen areas in Physics utilizing this design. Furthermore, using an action research approach provided for the least amount of interruption to the school's usual routine and was more controllable since the Researcher conducted the study within the allocated Physics times of the school day.

The research was divided into three primary phases: pre-intervention activities, intervention implementation activities, and post-intervention activities. The main goal of this study is for the Researcher to provide an instructional inquiry package for students. Guided inquiries are the topics covered in this teaching and learning guide provided by the Researcher for the students. The kit included study materials for the pupils as well as an assessment worksheet. Student interaction with manipulative materials and formulation of responses to questions were among the steps included in the package, which included: presentation of the topic, distribution of study guides and manipulative materials to students, monitoring of student learning by the teacher, discussion of ideas with the entire class by students, and evaluation. Students who find the assignment difficult to complete may bargain with the instructor to have the task changed. It was necessary to apply this inquiry package throughout the intervention stage.

3.2 Population

An entity or group of individuals upon whom a study intends to gain information, according to Punch (2006), is referred to as a population. In a related vein, Creswell (2008) believes that a population is a collection of humans or things that have a common set of traits.

The Researcher went on to clarify that a population determines the boundaries within which research results may be applied, and that a population might be huge or small, and that a Researcher must pick which group to include in the study. In research, there are two sorts of populations to consider: the target population and the readily available population (Castillo 2009). According to Castillo (2009), the target population is sometimes referred to as the theoretical population, and it refers to the group of persons to whom Researchers are interested in generalizing the findings. According to the Researcher, the accessible or readily available population is the population that Researchers can easily reach, work with, and apply their findings to, whereas the inaccessible population is any other group.

The participants in this research were all science students at Nafana Senior High School in the Jaman North District. The accessible population consisted of second-year Physics students from Nafana Senior High School. The selection of SHS from two Physics students was made because they had reached a certain degree of maturity and confidence required for the guided inquiry method. Likely, students will also be more attentive to the instructional tactics since there is no strain of preparing for an external test on their shoulders.

3.3 Sample

A sample is a subgroup of people taken from a larger population for the purpose of research (Robson, 2002; Punch, 2006). The notion of sample is derived from the Researchers' difficulty to examine all of the people in a particular group. The sample must be a fair representation of the population from which it was selected, and it must be of sufficient size to allow for statistical analysis to be performed on the data (Castillo, 2009). There are two basic categories of samples, according to Jackson and Trochim (2002), which are probability samples and non-probability samples. Probability samples are the sort of sample in which every member of the population has an equal possibility to be chosen for inclusion in the sample, according to the author. Some of the probability samples are basic random, systematic, and stratified samples.

The form of a sample where each member of the population under investigation has an equal probability of being picked into the sample is referred to as a simple random sample. It is possible to have a homogenous representation of the population by using a simple random sampling method (Amoani, 2005). A systematic sample is one in which the subjects chosen from a population list are chosen in a systematic manner rather than in a random one (Cohen, Manion & Morrison, 2008). This kind is more suitable when working with a very big population and when high sample size is required to be used effectively.

The stratified sample type is one in which particular subgroups or strata are picked from the population in the same proportion as they exist within that subgroup or stratum. According to Fraenkel and Wallen (2000), stratified sampling entails separating a population into homogenous groups, with each group comprising samples with comparable characteristics, and then randomly selecting samples from each group. The use of this sample type guarantees that diverse strata of the population are adequately represented in the study. It also improves the accuracy of the sample and is easier to use in real situations than other methods.

A non-probability sample is a sample that has been purposefully chosen to represent the larger population; it seeks only to represent a specific group, a specific named section of a larger population, such as a class of students, a group of students who are taking a specific examination, and a group of teachers. Various forms of nonprobability samples are used in research: convenience sample, quota sample, snowball sample, and purposive sample, among others (Cohen, Manion & Morrison, 2008). According to Patton (2002), a purposive sample is one in which the Researchers handpick the individuals who will be included in the sample based on their evaluation of their typicality or presence of the specific qualities that are being sought.

Purposive sampling was employed to choose the participants for this research. The students that participated in the research were second-year home economics and biology majors. The sample size was 50 students, with 48 of them being females and the other two being males, according to the findings. Because these students over-relied on instructors for knowledge in the available population, and their replies to oral questions and classroom activities suggested certain misunderstandings, the Researcher chose a purposive sample for this study. The class was once again dominated by females, and the Researcher viewed this as a chance to demystify the study of science among young women in general.

3.4 Sampling Technique

According to Amoani (2005), sampling is the technique by which elements or persons are selected from a community to reflect the characteristics of that group.

Furthermore, according to Kumekpor (2002), sampling is defined as the use of a certain technique in the selection of a portion with the explicit intention of deriving from its description or estimations certain qualities and characteristics of the whole.

When doing educational research, there are two kinds of sampling strategies that are used: probability sampling and non-probability sampling (Cohen, Manion & Morrison, 2008). According to Cohen, Manion, and Morrison (2008), randomness is critical in the process of probability sampling and is a critical component of the whole process. However, non-probability sampling is based on the Researcher's opinion rather than on the distribution of data. In their paper, the authors explain that there are numerous sorts of sampling procedures, some of which include basic random and stratified (probability) samplings and convenience and purposeful (non-probability) samplings. In simple random sampling, all units of the target population have an equal chance of being picked, they claim, and this strategy is ideal when the population under study has traits that are comparable to the qualities of interest in the first place. Stratified sampling is the process of splitting a population into several homogenous groups, or strata, before sampling them. Each group comprises people that have comparable features, and a sample is selected from each group or stratum as a result of the sampling process. In situations when it is necessary to include members of all categories of the target population in the sample, the stratified sampling approach is used. According to Amedahe (2002), convenience sampling is a kind of non-probability sampling in which respondents are chosen based on their proximity to the surveyor or their availability to serve as respondents. This method of sampling is used in qualitative research as well as in other studies where representativeness is not a major consideration. Non-probability sampling is a type of sampling in which decisions about who should be included in the sample are made by the Researcher. These decisions are made by a variety of criteria, which may include specialized knowledge of the research issue, as well as capacity and willingness to participate in the research (Bernard, 2002). When a Researcher seeks a sample of experts, such as in the case of a need assessment utilizing the key informant method, this strategy is utilized to achieve that goal.

As a result of the Researcher's experience teaching science and Agricultural science courses continuously for the previous four years, the Researcher saw that students were too reliant on instructors for knowledge. Purposive sampling was employed to choose the sample for this study. Additionally, certain misunderstandings were discovered in the students' replies to questions, and some of them exhibited unfavourable attitudes such as laziness, lack of enthusiasm, and absenteeism during Physics sessions.

3.5 Research Instrument

The tools for collecting data to answer research questions are known as research instruments. Zohrabi (2013) points out that there are a variety of data gathering strategies available.

A questionnaire, an interview, classroom observation, and a test are some of the methods the Researcher uses, according to the Researcher these instruments are explained in further detail below.

3.5.1 Observation

According to Annum (2015), observation is the process of observing people, events, situations, or phenomena and gaining first-hand knowledge about specific features of those people, events, situations, or phenomena that are being seen or experienced. It is concerned with the perception of information via the senses of sight, hearing, taste, touch, and smell. According to Annum (2015), there are several different kinds of observations. They include participant and non-participant observation. According to the Researcher, in participant observation, the observers become members of the group they are supposed to be studying. They watch from inside the group and, in an ideal situation, their presence as a Researcher is not revealed.

Non-participant observation, on the other hand, is when observers examine their subjects from the outside without being a part of the setting in which they are being watched. When doing qualitative research, Annum (2015) explains that observation is one of the most significant strategies for acquiring thorough data. This is particularly true when a composite of both oral and visual data becomes essential to the study. Ary and Razaviet (2002) note out that observation is used when children are to be examined while engaged in a variety of activities such as games, acting, or community work.

The data for this research was gathered via the use of two instruments. The inquiry package and the observational checklist are two examples. The Researcher created them and administered them to the students during the intervention stage.

3.5.2 Inquiry Package (IP)

The inquiry package (IP) contained instructional objectives, primary source materials which are the study guides, manipulative materials and self-assessment worksheet.

The inquiry package was tagged Instructional Package for Guided Inquiry (IPGI). The IPGI had been compared with the standard of Akinbobola (2009) and Yusuf and Afolabi (2010).

Each student was given IPGDI to learn on their own. A student follows the instructional guides which are the primary source materials, interact with the manipulative materials and carries out activities independently. The Researcher asked facilitating questions that stimulate and help the learner to think and which are relevant to the assignment or task is given. However, students who find the task difficult to do may negotiate with the teacher for a change. At the end of the lesson, the students answered self-assessment questions in the worksheet as evaluation. In addition, the students were given homework.

3.5.3 Checklist for Observational Skills in the Science Process

The Researcher devised and utilized an observational checklist to take inventory of the scientific process abilities that were shown by the students throughout the lessons. Following the grading of students' classroom activities, some of the process abilities were tested as well. The checklist included subjects for the lessons as well as the scientific process skills that were to be observed.

3.5.4 Observational Checklist on Student Attitude

The information on students' attitudes toward science was gathered via the use of an observational checklist. The form was used to assess students' attitudes about attendance and engagement in the classroom, as well as their overall attitude toward learning. It was created in such a manner that it incorporates certain qualities of attitude (presence and involvement) that should be monitored, as well as short observations or notes that should be taken into consideration. To prevent the Hawthorn effect, the Researcher took notes after each class and wrote them down. Hawthorn effect is a form of reactivity whereby subjects improve or modify an aspect of their behaviour which is being experimentally measured, in response to the fact that they know that they are being studied (McCarney, Warner, Iliffe, Van Haselen, Griffin & Fisher, 2007).

3.6 Validity of the instrument

The validity, according to Creswell (2008), is defined as the degree to which an individual's scores on a given instrument make sense, are meaningful, and enable a Researcher to draw sound conclusions from the sample under investigation, and that validity is concerned with determining whether an instrument measures what it is intended to measure. A further explanation provided by Cohen, Manion, and Morrison (2008) is that the validation of a research instrument must demonstrate that it fairly and fully covers the domain or the items that it is intended to cover. My supervisors gave their approval for the learning package used in this research.

3.7 Reliability of the instrument

Reliability according to Cohen, Manion and Morrison (2008), means that scores from an instrument are stable and consistent; scores should nearly be the same when Researchers administer the instrument multiple times and also scores need to be consistent. To ensure reliability, the items in the instruments were designed to cover the key areas raised in the research questions.

There are a number of different aspects to reliability. One of the aspects is to check for internal consistency. Internal consistency refers to the degree to which items that makes up a scale ―hang together" or measure the same underlining construct

3.8 Procedure for Data Collection

The data for this study was gathered via the use of research tools. It was decided to split the data-gathering technique into three parts: the pre-intervention, the intervention, and the post-intervention phases.

3.8.1 Pre-intervention phase

It took two weeks to complete this step of the research project. When the Researcher notified the school's headmistress about the study work, the Researcher intended to do at the school, the Researcher asked for his cooperation and aid in the process. The Researcher then worked with the school's storekeeper to ensure that all of the students had access to the approved Physics textbooks (Aki-Ola Physics and Atta-Kay Physis). A termly plan of work or forecast was created, and each student was given a copy to keep track of their assignments.

3.8.2 Intervention phase

The execution of the inquiry package was the focus of this phase of the project. This stage lasted six weeks in total. During this stage, the students participated in activities and offered comments to the instructor. The Researcher kept an eye on the actions of the students and interfered when required. In this research, five lessons were identified and discussed in detail.

3.8.3 Implementation of the Instructional Package for Guided Inquiry (IPGI)

There were six phases in all. The following were the actions that were taken by the Researcher.

Introduction

After reviewing the students' relevant prior knowledge using a question and response approach, the Researcher presented the lesson and explained what would happen next. This stage is critical for arousing the students' attention and bridging the gap in learning by activating students' past knowledge while also allowing them to take in the new information.

The practice of the Instructional Package for Guided Inquiry (IPGI)

The students were provided with study aids, manipulative materials, and self-assessment task papers by the Researcher during class. The students followed the instructional guidelines, engaged with the manipulative materials, carried out exercises on their own, and reported their observations. Students who found the work difficult to complete, negotiated with the instructor to have it changed.

Monitoring and intervening.

While the students were doing the assigned job, the Researcher moved round the class and watched each student as they completed their task. The Researcher selected questions at random from a list of enabling questions that encourage students to think critically and are related to the project or work at hand. Participants were observed while working on the assignment and the Researcher guided when they sought clarification from the Researcher.

Assessment

An individual student was assessed by the Researcher using the checklist created for the students as well as the worksheet activity. Participant knowledge was assessed via the use of a checklist, which was created by the Researcher to keep track of individual points. Student participation in classes was evaluated based on their voice of opinion, their asking of questions, and their contributions. Each time a person asked a major question about the package, for example, the Researcher granted one additional point to that participant. Any question that was deemed unimportant did not earn a bonus point. Each student completed the assignment by answering the self-assessment questions. During the assessment activities, students were not authorized to assist one another in any way

Observational checklist

In this exercise, the Researcher devised and utilized a checklist to keep track of the students' scientific process abilities throughout the lessons. In addition to grading the students' classroom activities, some of the students' process abilities were also evaluated. The Researcher crossed (crossed) a box if the process skill was not seen and ticked (ticked) a box if the process skill was observed After wards, the findings were compiled and examined.

3.9 Data analysis procedure

Data analysis is the process of reducing the amount of information to make it more comprehensive (Jack & Norman, 2003). According to Bogdan and Bilklen (2003), data analysis refers to the act of carefully examining and organizing interview transcripts, field notes, and other materials that have been acquired to create conclusions from the research. Data analysis is the process of transforming raw data obtained into meaningful information via the use of statistical methods.

In this research, qualitative data analysis techniques were used to gather information. Reports on the lessons were given and discussed, with the development of the students from lesson to lesson being taken into consideration. The report included information on the activities that were completed, the interactions that occurred, the amount of engagement in the lessons, and the advancement of the lessons. Each of the five classes was evaluated qualitatively, with observations taken throughout each lesson and conclusions drawn from the five lessons. Discussions of the results were conducted by the research questions posed. Conclusions and suggestions were drawn after conducting an in-depth analysis of the data.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Overview

This chapter deals with the presentation of results and findings from five representation-teaching lessons. The discussions were based on the teaching and learning activities that went on in the classroom, the procedures used as well as the observations made during the lessons. Data collected from students‘ weekly intervention exercises after lessons were analysed qualitatively. The students‘ responses were mainly presented in the form of frequencies and percentages. Descriptive analyses of results were done to provide the basis for the findings. The findings were analysed based on the research questions.

4.1 Report on Intervention Lesson 1

Duration: 2 hours

Topic: simple pendulum

Objectives: By the end of the lesson, the student will be able to:

1. Determine the time t for 20 oscillations.
2. Determine the periodic time (T) or the period of oscillation.
3. Plot a graph for the period of a simple pendulum

Relevant Previous Knowledge: Students asked to read and record the time used to walk from the front of the class to the back of it.

Activity one

The Researcher provides the participants to follow the set of manipulation materials and instructions in the learning package. The instructions are as follow: you are provided with a retort stand, pendulum bob, thread, meter rule and stopwatch.

1. Set up the retort stand and mount it on a table.
2. Tie the pendulum bob with the thread provided.
3. Tie the other end of the thread to the retort stand
4. Measure the length, l of the thread from the end of the stand to the middle of the bob 100cm
5. Displace the bob at a very small angle
6. Take the time for 20 oscillations.
7. Read and record the time for the 20 oscillations.

Activity two

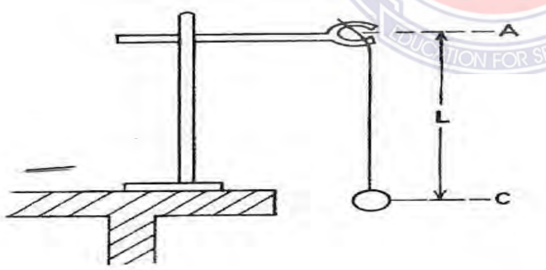


Figure 3: Pendulum set-up

Suspend the pendulum bob from the clamps as illustrated in the diagram. Adjust the pendulum such that AC = 90 cm. displace the pendulum bob slightly such that the bob oscillates in vertical plane. Measure and record the time t for 20 completes oscillations. Evaluate the T and $\sqrt{L}$

Figure 4: Students performing simple pendulum experiment

Activity three

Repeat the procedure for four other valves of L = 80cm, 70cm, 60cm, and 50cm. Tabulate your readings. Plot a graph of T on the vertical and $\sqrt{L}$ on the horizontal. Determine the slope s of the graph. Evaluate g = $\frac{4\pi^2}{s^2}$

Figure 5 students performing simple pendulum experiment

The use of guided Inquiry

The Researcher stepped forward and said, "Okay, what kinds of things did we talk about yesterday?" The class reviewed yesterday's introductory lesson about potential energy and kinetic energy, and the vocabulary term, the period of a pendulum. The Researcher repeated a demonstration for determining how many swings a pendulum made in one second. As Brenda read the value on the stopwatch, the Researcher pulled the weight back and released it.

Kofi called out, "Stop!" and the Researcher grabbed the weight in mid-swing. "Okay, we had this problem yesterday," said the Researcher. "What was the problem with this method?" The students concluded that one second wasn't long enough to measure the full swing of the pendulum. They suggested timing the swings for at least 15 seconds to capture a full swing and collect enough data to accurately calculate the measurement.

The Researcher accepted their strategy and then introduced a new problem, setting the stage for the next activity. "Remember, good science starts with a problem,". "Here's the problem that the Researcher want you to address over the next three hours: What affected the period of a pendulum? Did anything make the number of swings per second change, or was it always the same? That's what you were going to solve." Before the students broke into small groups, the Researcher led them in a brainstorming session. The Researcher wrote their ideas about what might influence the swing of a pendulum on the chalkboard.

"Air pressure," suggested Woli. "Okay, if we did this experiment on another planet or someplace that had more air pressure, that might change it," agreed the Researcher, "but that's a variable that's going to be hard for us to control." "Length of string," offered Daniel. "Okay, that's a good one. Would a really short string have a short period or fast oscillation? Any discussion about the length of the string before I go on?" the Researcher waited a few seconds before continuing, "Are there others?" "How heavy the weight is," said Melinda. "Excellent idea," said the Researcher. "I like that one. The weight, yeah! Would a real heavy weight make a slower oscillation, or would it make a faster oscillation? How could we test that?" "Try different weights," said Greg. "Right!" The Researcher was clearly pleased but pressed for more ideas. "Any other hypotheses about the period of the pendulum?" "The diameter of the string might affect it," said Matthew.

"String might matter. Okay, good idea. I don't have a lot of different string widths, so that's not a variable that everyone will be able to test, but if you want to try it, Matt, after you test the other variables, that would be an interesting experiment to do." Another student said, "Aerodynamics could make a difference." "What do you mean by that?" probed the Researcher. "It could increase the drag on the pendulum." "Okay, that would be good to test, too." "What about friction at the top of the string, where the string is attached to the wire on the ceiling?" asked Kofi. "Good. Friction at the point where the string meets the wire."

The students moved into small groups to set up their experiments on pendulums. Immediately, they started searching through drawers, shelves, closets, and cabinets for materials with which to conduct their investigations: string, wire, weights of all sorts. They were familiar with this routine; only occasionally did the Researcher prepare materials for them in advance. With materials in hand, they searched around the room for interesting places to fasten their pendulum. Everything from bronze weights to a pair of scissors served as the pendulum weight. Members of each group took turns manipulating their pendulum, timing its swings, and recording data. After 60 to 120 minutes, they returned to their desks to report the data they had collected. As it turned out, the students had experimented with only two variables: the length of the string and the weight. "Looking at the data, what do you think?" asked the Researcher. "Give me some hypotheses." "I don't think weight affected it a lot," said Melinda, wrinkling her brow. "Why do you say that?" asked the Researcher. "Because the results for each trial were about the same." "Yes, the periods were almost exactly the same, although we changed the weight in all five trials. Maybe you're right, maybe the weight didn't make the pendulum swing any faster or slower," said the Researcher. "How about the length of the string?" "The shorter the string, the faster the period," said Jennifer. "It appeared that way, didn't it?" said the Researcher. "As we got the string shorter, it appeared to go faster. Did that mean it was true? Sure, because when we repeated our experiments, to test each length of the string four or five times, it proved so. This gave us enough data points to reach a more accurate average for calculating the period of the pendulum."

The Researcher reviewed the day's activity. "Today, we followed the scientific process—we brainstormed ideas about what might affect the period of a pendulum; we did a few tests of each variable, collected and averaged data; and then drew some conclusions based on that data," he said. "Tomorrow, we're going to retry our experiments." Trina raised her hand and asked, "What if you were to hang the weight from two strings attached to the ceiling, like a swing?" "Good one! Nobody ever suggested that variable," said the Researcher. "Why don't you try that tomorrow?" Trina smiled and collected her books as the school bell rang. The next class of students was already pouring in the doorway as Trina and the others left.

Evaluation

1. State two precautions that are taken to ensure accurate results

   Student one: I closed the windows to avoid the interference of wind during the experiment.

Student two: I made sure that the measurements are accurate and precise to prevent errors in the calculations

Student three: error of parallax was avoided when measuring the length of the pendulum using meter rule.

2. Determine from your graph the period of the pendulum for L = 75

   Student one: log T = 0.26s

   Student two: log T = 0.25s

   Student three: log T = 0.28s

3. State two factors on which the period of oscillation of a simple pendulum depends

Student one: (1) the length of the pendulum (2) the acceleration due to gravity

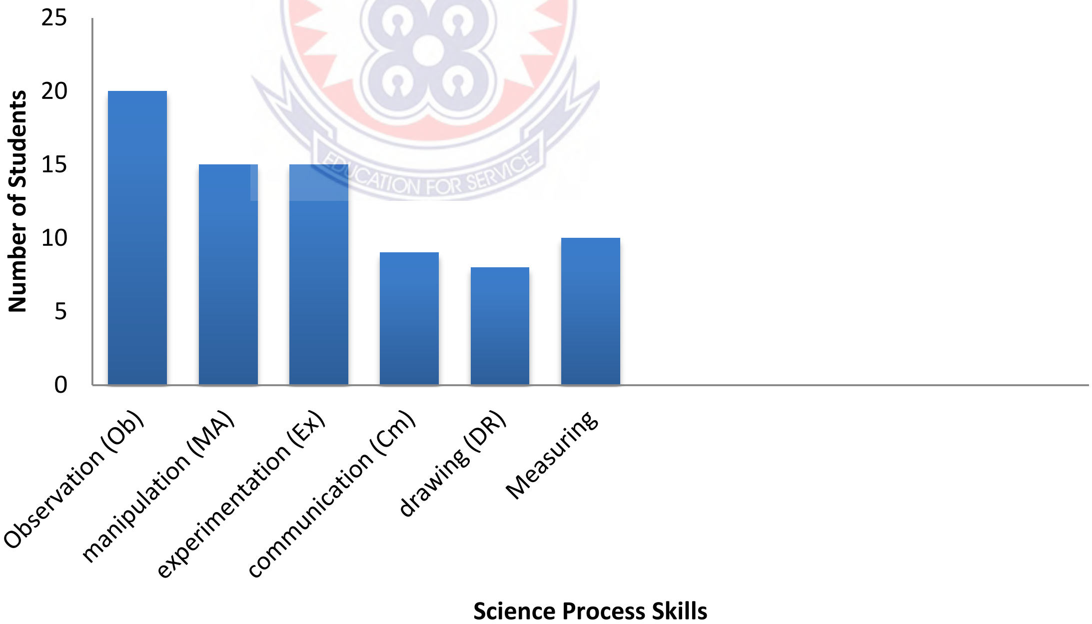


Figure 6: A graph of number of students against science process skills demonstrated by students for experiment 1

Table 1: Student's performance after activity one

Themes	Total number of students	correct answers	partially correct answers	incorrect answers
Table	20	3(15.00%)	5 (25.00%)	12 (60.00%)
Scale	20	6 (30.00%)	2 (10.00%)	11 (55.00%)
Points plot	20	3 (15.00%)	0	17 (85.00%)
Slope	20	2 (10.00%)	0	18 (90.00%)
Precaution	20	13 (65.00%)	7 (35.00%)	0

Data from Table 1 showed that few students 3 (13.3%) were able to construct the table of values correctly. Twenty-five percent of students comprising of 5 students partially got the table of values correctly. As many as 12 (60.0%) of the students got the table of values wrong. (An answer is partially correct when the student is not able to score the full marks for that theme)

Thirty percent of the students consisting of 6 students were able to find a scale for their values correctly. Few students, 2 (10.0%) of the students were partially right. Majority of the students about 85.0% had incorrect scale for their values.

Few students, 3 (15.0%) of the students were able to plot their points accurately. No student, 0 exhibited partially correct plotted points. Seventeen students comprising of 85.0% got the question pertaining to plotted points incorrect

Few of the students about 10% of the students were able to determine the slope of the graph correctly. Eighteen students comprising 90% of the students could not determine the slope of their graph correctly.

Few students, 7 (35.0%) were able to state the precaution partially correctly. Majority of the students, 13 (65.0%) got the precaution correctly stated.

Finding from lesson one

1. The use of groups in teaching physics had greatly improved students _conœptual understanding of physics.
2. Employing guided inquiry strategies during classroom discourse made students active and attentive in class as the class becomes interactive.
3. Appropriate feedbacks given to students' questions spurs students on to ask more relevant questions
4. Majority of the student (17) could not plot their points
5. Most of them (13) were able to state their precaution but few did it partially
6. Eleven (11) out of the twenty (20) students representing 65% had problems in finding the scale of the graph .
7. Twelve (12) students (60%) were not able to determine all the columns from the learning pack needed for the table
8. The few that were able to get a reasonable scale for the graph were not able to locate the points on the graph.

4.2 Report on Intervention Lesson two (2)

Duration: **Two hours (2h)**

Topic: **Simple Pendulum**

Objectives: by the end of the lesson, a student should be able to:

- Read and record the period T of oscillation of a simple pendulum
- Determine a suitable scale for the instrument
- Plot the exact points on the graph

Relevant Previous Knowledge: Students asked to read and record the time use to walk from the front of the class to the back of it.

Activity one

The Researcher provides the participants with set of manipulation materials and instructions in the learning package. The instructions are as follow: you are provided with a retort stand, pendulum bob, thread, meter rule and stopwatch

- Place the retort stand on a laboratory stool or bench. Clamp the split cork.
- Suspend the pendulum bob from the split cork such that the point of support P of the bob is at a height H = 100cm above the floor Q. the bob should not touch the floor and H should be kept constant throughout the experiment.
- Adjust the length of the thread such that the center A of the bob is at a height y = AQ = 20cm from the floor.
- Displace the bob such that it oscillates
- Take the time t for 20 complete oscillations
- Determine the period T of oscillation and Evaluate T^2
- Repeat the procedure for four other values of y = 30.0 cm, 40.0 cm 50.0 cm and 60.0 cm, in each case determine T and T^2
- Plot a graph of T^2 on the vertical axis and y on the horizontal axis, starting both axes from the origin (0, 0)

Activity two

The Researcher guided the students on how to determine a relevant scale of a graph. Students were asks to identify their axes by labelling them appropriately. They were asked to label the vertical axis with T^2/s and the horizontal axis with y/cm. the students were asked to count the number of bigger boxes on the vertical axis, which is

12 boxes and that of the horizontal axis which 10 boxes. The Researcher used one student‘s tabulated values to guide the whole class on how to find a reasonable scale for a graph.

To get a scale on the vertical axis you must first pick your highest value that will be plotted on that axis. Divide the highest value by 12. Take note of odd scales to avoid it. The scale must contain these numbers or their sub-multiples, 1, 2, 4, 5 and 10. If the answer is odd scale, then you round it to the nearest even scale for that axis. Assuming the highest value is 3.28. Then you divide that number by 12. (3.78/12 = 0.23) since 3 and its multiples and sub-multiples are odd then we round it to 0.4. This means that we start from 0.4 and increase with that number till we get to the last.

To get the scale for the horizontal axis, first count the number bigger boxes in that axis. The number of bigger boxes is 10 and then divides the highest value on the table that will be plotted on that axis. By not forgetting the odd scale and its multiples and sub-multiples, for instant, if the highest value is 60.0, then divide it by 10. (60.0/10 = 6.0), this can be used as your first scale and keep add it to get the next and the one that follows. You may also use 10.0 as your scale.

Activity three

Table 2: Values of T2 and y

T^2/s^2	3.28	2.66	2.28	1.74	1.49
y/cm	20	30	40	50	60

The Researcher guided them on how to plot or locate a point on the graph. To plot a point on the vertical axis you need to first take the point that will be plotted divide it by the first graduation on the axis and multiply the answer by 10. To locate 3.28 on the vertical axis, 3.28/0.4= 8.2 and multiply the answer by 10, this implies, (8.2* 10 =

82). This means that you are counting the smaller boxes on your vertical axis 82 of them to get 3.28. To get the intersection point on the horizontal axis divide 20 by 10 and multiply the results by 10. (20/10 * 10 = 20). This means that count the smaller boxes 20 on the horizontal axis.

Similarly, to plot the points (2.66, 30), locate the box on the vertical axis by the same process (2.66/0.4*10 = 66.5. ≈ 67), count the smaller boxes 67 of them for the vertical axis. To get the corresponding point on the horizontal axis, (30/10*10 = 30). The point (2.66, 30) can be located by counting the small boxes 67 on the vertical and 30 on the horizontal axes.

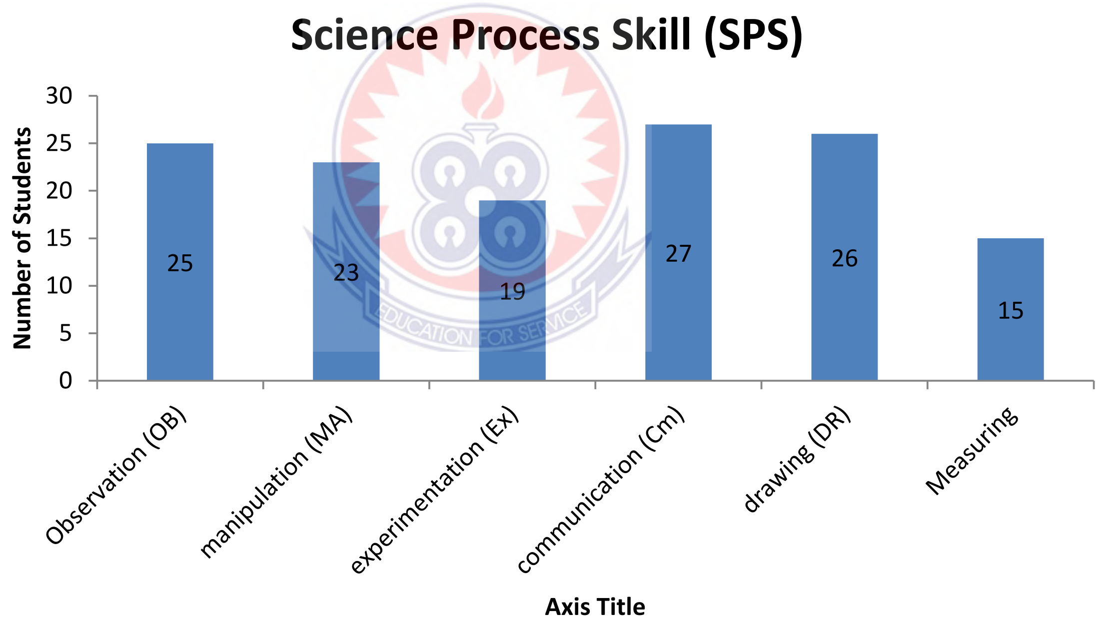


Figure 7: A graph of number of students exhibiting science process skills for activity 2

Table 3: Student's performance after practical two

Themes	Total number of students	correct answers	partially correct answers	incorrect answers
Table	28	15(53.57%)	7(25.00%)	6(21.43%)
Scale	28	20(71.14%)	5(17.86%)	3(10.71%)
Points plot	28	17(60.71%)	4(14.29%)	7(25.00%)
Slope	28	19(67.86%)	0	9(32.14%)
Precaution	28	22(78.57%)	5(17.86%)	0

Data from Table 3 shows that majority of the students 15 (53.57%) were able to construct the table of values correctly. Twenty-five percent of students comprising of 7 students partially got the table of values correctly. Few students 6 (21.43%) got the table of values wrong.

About Seventy-one percent of the students consisting of 20 students were able find a scale for their values correctly. Few students, 5 (17.86%) of the students were partially right. Very few of the students about 10.71% were incorrect.

Majority of the students, 17 (60.71%) of the students were able to plot their points accurately. About Fourteen percent of the student, (4) exhibited partially corrected plotted points. Seven students comprising of 25.0% got the question pertaining to plotted points incorrect

Majority of the students about 67.86% of the students were able to determine the slope of the graph correctly. Nine students comprising 32.14% of the students could not determine the slope of their graph correctly.

Most of the students, 22 (78.57%) were able to state the precaution correctly. Minority of the students, 5 (17.86%) got the precaution partially correctly.

Findings from lesson 2

Majority of the students were able to determine the reasonable scale and plot their values. The following skills were acquired by the students in the lesson:

1. The total number of students who participates in the lesson has increase from 20 to 28. This is about 40% increase from the last attendance.
2. The number of students having problems in finding the scale of the graph since the values are decimal numbers has reduced from 65% in lesson one to 52% in lesson two.
3. The number of students that were not able to determine all the columns from the learning pack needed for the table has also reduced from 60% to 49%
4. **Manipulating skill** was acquired when the students hang the pendulum bob on the inextensible string. Twenty-three out of twenty-eight students representing 82.14% exhibited this skill. This skill was also displayed during the measurement of the string to the pendulum bob.
5. **Holding skill** was demonstrated when the students held the stopped watch firmly between their fingers
6. **Cutting skill** was demonstrated when students cut off the excess length of the string after the measurements.
7. **Observing skill** was acquired when students observed the experiment set-up drawn on paper to identified the instruments and set them up in the same way. Twenty-five of twenty-eight students (89.28%) listen, watched and payed attention in class.

8. **Communicating skill** was acquired when they tabulated four values of the period and the length. It was also displayed when they followed the Researchers' instructions and performed the tasked. 27 of them (96.43%) showed this skill.

4.3 Report on Intervention Lesson three (3)

Duration: **Two hours (2h)**

Topic: Rate of cooling of water and kerosene

Objectives: by the end of the lesson, a student should be able to:

1. Construct a composite table for the readings
2. State an acceptable precaution during the experiments

Relevant Previous Knowledge: Students asked to tell their experience in putting their finger in a melting ice.

Activity one

The Researcher provided the participants with set of manipulation materials and instructions in the learning package. The instructions are as follow: you are provided with a calorimeter, weighing scale, thermometer, hot water, kerosene and a stirrer.

Weigh and record the mass M_c of the given calorimeter and the stirrer. Pour some hot water into the calorimeter until it reaches the mark indicated inside it. Stir the content of the calorimeter constantly. Observe and record the temperature at one-minute intervals, when the cools over the range 65^0C to 35 ^{o} C. Tabulate your readings. Weigh and record the mass of the calorimeter, stirrer and the contents and hence determine the mass M_w of the hot water used. Pour the water out and wipe the inside of the calorimeter. Repeat the experiment with the calorimeter now filled to the same mark with the given hot kerosene, allowing it to cool over the same temperature range.

Tabulate your readings. Determine also the mass M_k of the hot kerosene used. For each of the experiment, plot a graph with temperature on the vertical axis and time on the horizontal axis. Use the same axis for both graphs. Draw smooth curves through each set point. From your graph, determine the time t_w taken for the calorimeter and water to cool from 65 ^oC to 50 ^oC. determine also the time t_k taken for the calorimeter and kerosene to cool from 65 ^oC to 50 ^oC.

Activity two

The Researcher guided the students to construct a composite table for the data. Before table is drawn then you must first read the whole question from the beginning to the end. While you are reading through you take note of places that asked to read and record, evaluate or calculate, and determine a perimeter in the question. For this question the things asked are as follows; mass of the calorimeter M_{c}, mass of calorimeter and water M_{cw}, mass of water M_w, mass of calorimeter and kerosene M_{ck}, mass of kerosene M_k, time T, temperature of water T_w, time of kerosene T_k.

The Researcher guides the students to draw a composite table with the heading and units of the quantities in them.

Table 4: Data from experiment

Time/min	00	0.5	1.0	1.50	2.0	2.50	3.0	3.0	4.0	4.50	5.0	5.50
Water Temp/^0C	65.0	61.0	57.5	55.5	53.0	51.5	49.5	48.0	47.0	46.5	45.5	45.0
Kerosene Temp/^0C	65.0	59.0	56.0	53.0	51.0	48.5	47.0	45.5	44.5	43.5	43.0	42.7

Activity three

The Researcher took them through on the precautionary measures they must take in performing the experiment. Researcher explained to them how to state an acceptable precaution. Precautions must be in the past tense because you have finished performing the experiments. They must not be instruction from the question. They must be things you can control during the experiment. Some of the acceptable precautions are as follows

1. Use a piece of cloth in handing the calorimeter to minimize heat loss by conduction
2. Place the calorimeter on a cork mat to serve as insulator
3. Stir the water gently and continuously in order to obtain a uniform distribution of temperature.

How guided inquiry was used

The Researcher reviewed yesterday's lesson about the measurement of heat, and the vocabulary term was the rate of cooling. The Researcher demonstrated the determination of the temperature drop in a liquid in one second. As Enoch readied the stopwatch, the Researcher inserted the thermometer in the student armpit and removed it at once.

The students were not able to read the temperature change and suggested that for a temperature to change, it must be read for about one to five minutes intervals. The Researcher accepted the students' suggestions and introduced a new problem for the day. "Between water and kerosene, which one will cool faster than the other, or do they cool at the same time? That's what you are going to solve. Before you break into your smaller groups, let's brainstorm on the question."

"Sir, I think water will cool faster than kerosene," said Helena. "The environment temperature is cool, and water is less dense than kerosene." "That temperature is called ambient temperature, and water is denser than kerosene," said the Researcher. Joe said, "Water cools faster than kerosene because water responds fast to the ambient temperature than kerosene."

The students then broke into their groups to start their experiment. Some started heating water, while others weighed the given calorimeter and took the initial temperature of the heated water. When the water reached about 70°C, they transferred it into the calorimeter with a thermometer inserted. They started the stopwatch, and some stirred the hot water to achieve a uniform temperature. Others were assigned to record the temperature at every half a minute and record it against the time. They repeated the experiment using kerosene. Members of each group took turns manipulating the materials, from heating water and kerosene to taking measurements with thermometers and stopwatches, to stirring and recording the data.

After 60 to 120 minutes, they returned to their desks to report on their data and graph for each group. The Researcher asked them to report, starting from group one. "Sir, looking at our data under the same ambient temperature and with a silver-coated calorimeter, the kerosene cools faster than water," said group one. All the other groups agreed with the conclusion reached by group one. Group two reported, "Sir, the graph of the two materials shows that the temperature decreases as time increases."

"In your own view, what accounts for the fast-cooling rate of kerosene as compared to water?" asked the Researcher. Enoch said, "Sir, the gradient of a cooling curve is related to the conductivity of the substance. Kerosene has more conductivity than water." "Very good, it is not only conductivity but also heat capacity and external temperature (ambient temperature). Water has the highest heat capacity among every other liquid."

The Researcher reviewed the day's activities by saying, "Today, we followed the scientific process and came to the conclusion that kerosene cools faster than water because water has the highest heat capacity, and kerosene is more conductive than water.

Evaluations questions

1. Define the term specific heat capacity

   Specific heat capacity is the quantity of heat energy required to raise the temperature of 1 kg of a substance by 1 kelvin.

2. Calculate the quantity of heat energy required to raise the temperature of 15g of water by 30 ^{0}C. (Specific heat capacity of water 4.2×10^{3} $Jkg^{-1}K^{-1}$)

   Quantity of heat energy required, $Q = mc\theta$, where $\theta = 30\ ^0C$, $m = 15g = 0.015kg$ $c = 4.2 \times 10^{3}\ Jkg^{-1}K^{-1}$

   By substitutions, $Q = 0.015 \times 30 \times 4.2 \times 10^{3} = 1890J$

3. Calculate the final temperature on mixing 20 g of water at 100 ^{0} C with 30 g of water 10 ^{0} C

   Solution

   Heat lost by hot water at 100 ^{0} C = Heat gained by cold water at 10 ^{0} C

   Let θ_f be final temperature. At a steady state $Q_{hot} = Q_{cold}$

   $M_h\ C\ (100 - \theta) = M_c\ C\ (\theta_f - 10)$

   Where $M_h = 20g = 0.02\ kg$ $M_c = 30\ g = 0.030\ Kg$.

   Substituting the values

   $0.02\ c(100 - \theta_f) = 0.03\ c\ (\theta_f - 10)$

$2(100 - \theta_f) = 3(\theta_f - 10)$

$200 - 2\theta_f = 3\theta_f - 30$

$230 = 5\theta_f$

$\theta_f = 46\,^0C$

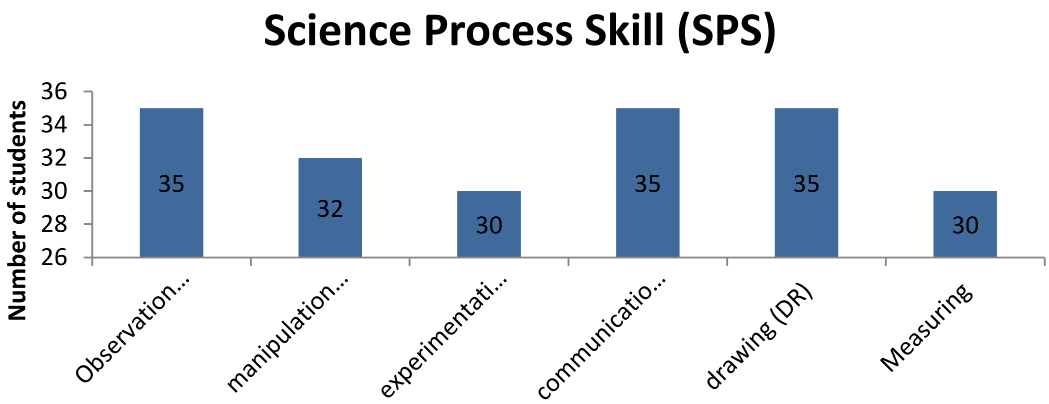


Figure 8: A graph of number of students exhibiting science process skills for activity 3

Table 5: Student's performance after activity three

Themes	Total number of students	correct answers	partially correct answers	incorrect answers
Table	35	35(100.00%)	0	0
Scale	35	33(94.29%)	0	2(5.71%)
Points plot	35	30(85.71%)	4(11.43%)	1(2.86%)
Slope	35	34(97.14%)	1(2.86)	0
Precaution	35	35(100%)	0	0

Data from Table 5 shows that 35(100%) of the students were able to construct the table of values correctly. None of the students got the table either incorrect or partially correct.

About Ninety-four percent of the students consisting of 33 students were able to find a scale for their values correctly. None of the students were partially right and very few of the students about 2.71% were incorrect.

Majority of the students, 30(85.71%) of the students were able to plot their points accurately. About Eleven percent of the student, (4) exhibited partially corrected plotted points while one (1) student comprising of 2.86% could not plot the points

Majority of the students about 97.14% were able to determine the slope of the graph correctly. One (1) student comprising 2.86% got it partially correct

All the students, 35(100%) were able to state the precaution correctly.

Findings from lesson 3

The students focused and concentrated on the learning package and the manipulative materials. The following skills were demonstrated by the students in this lesson:

1. Students were part of the class and this positively influence their understanding of the concept
2. The number of students having problems in finding the scale to the graph reduced from 52% in lesson one to 30% in lesson two, since the values were decimal numbers
3. The number of students that were not able to determine all the columns from the learning pack needed for the table has also reduced from 49% to 20%
4. Manipulating skill was exhibited when students regulated the tap of the Bunsen burner on and off during the boiling of the water bath. thirty-two students (92.43%) demonstrated this skill.

5. Holding skill was acquired when the students with the aid of a pair tongs to held the boiling water and transferred it into the calorimeter.
6. Measuring skill: was demonstrated when the students (30) representing 85.71 % measured the temperatures of the substance using thermometer.
7. Observing skill was acquired when all the students (100%) identified that, the temperature was rising and was able to read and record it according.
8. Communicating skill was acquired when all the students (100%) tabulated twelve values of the time and the temperature. It was also displayed when they followed the Researchers' instructions and performed the tasked.

4.4 Report on Intervention Lesson 4

Topic: Determination of the refractive index of a rectangular glass prism

Objective: After studying this package, students should be able to:

1. Perform an experiment to determine the refractive index of a rectangular glass prism.

Relevant Previous Knowledge: Students were able to state the law of reflection as the incidents ray the normal, and the reflected ray, at the point of incident all lies in the same plane.

Activity one

Each student was given a rectangular glass prism, drawing paper, drawing board, four (4) optical pins pencil and other necessary apparatus. Put the rectangular glass prism on the paper with one of its board faces on the sheet of the drawing paper. Trace the outline of the rectangular glass prism and label it as **ABCD.** Remove the prism and measure the thickness d of the prism. Draw a normal **SRN** to cut **AB** at **R** and **DC** at **N**. draw the line **TR** making an angle ***i*= 20** ^{0}.

Activity two

Replace the prism and erect two optical pins at P_1 and P_2 on the line **TR**. Looking through the prism in the direction **Y**, trace the path of the ray of light from the object pins which refract through the prism, by erecting two search pins P_3 and P_4 when they appear to be in straight line with the images of P_1 and P_2. Remove the prism and join P_3 and P_4 to meet DC at **Z**. produce **TR** to meet **DC** at **Q**. join **RZ**.

Activity three

Measure and record the value of r and the corresponding value of **ZQ** = y. determine the values of tan i, tan r and (tan i – tan r). Repeat the procedure for i = 30^{0}, 35 ^{0}, 40 ^{0} and 45 ^{0} . In each case determine the corresponding values of tan i, tan r and (tan i – tan r). Tabulate your reading. Plot a graph with y as the ordinate and (tan i – tan r) as the abscissa. Determine the slope of the graph.

Table 6: A sample Results from the experiment

i^{0}	r^{0}	*y/cm*	tan i	tan r	(tan i – tan r).
20	13	0.9	0.364	0.231	0.133
30	19	1.5	0.577	0.344	0,233
35	22	1.9	0.700	0.404	0.296
40	25	2.4	0.839	0.466	0.373

How guided inquiry was used

The Researcher reviewed the RPK of the students and started the day's lesson with them. Researcher performed a small demonstration by dropping a small stick in water and asked the students to observe the stick in the water. One of them said the stick was not too deep in the water, and another one said the stick was not straight and appeared to be bent in the water.

The Researcher accepted the students' observations and posed a new problem for investigation: What affects the angle of refraction? Or does the angle of refraction depend on something? "Sir, it depends on the two mediums through which it travels," one student answered.

"Good, so it means the ratio of the refractive indices of the two mediums that make up the interface," said the Researcher. Another student added, "It also depends on the incidence angle, or the angle of incidence." "That is very good," said the Researcher. "If you increase the incidence angle, will the refractive angle increase or decrease? This is what you are going to investigate."

The students moved to their various groups to set up their own experiments on the refraction of a glass prism. Immediately, they started searching through drawers, shelves, closets, and cabinets for materials with which to conduct their investigation: optical pins, drawing boards, papers, and thumb pins.

With the materials at hand, they pinned the drawing paper on the drawing board, placed the rectangular prism on it, and traced its outline. They measured the angle of incidence and, using incidence pins, traced the path of refraction and measured the angle with a protractor. Each member of the group took turns manipulating the materials to obtain results for reporting. After 60 to 120 minutes, they returned to their desks to report on their data and graphs.

From group three, they said, "Sir, from our table, it is clear that the refractive angle depends on the incidence angle." The Researcher asked, "How does it show in your data?" They replied, "Sir, as the incidence angle increased, the refractive angle also increased." The other groups also supported the conclusions of group three with similar data.

The Researcher reviewed the day's activity by saying that they had verified the statement using the scientific method and had observed some scientific processing skills.

Evaluations

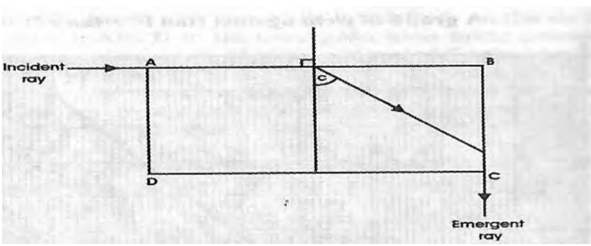
1.State two precautions you took in performing this experiment

i. The pins were placed at least 5 cm apart in order to obtain the best tracing path of the refracted ray of the light
ii. Avoided error of parallax when taking reading with the protractor
iii. Used well sharpened pencil to avoid thick and double lines in tracing the path of the light ray

2.Define refraction

Refraction is the change in the velocity of light from one optical homogeneous medium to another of different refractive index.

1. A ray of light from air strikes the face AB of a rectangular glass prism ABCD and emerges along the face BC in the direction of C of the prism. Draw a ray diagram of the arrangement



2. A coin at the bottom of a swimming pool appears to be 1.60 m form the surface of the pool. What is the depth of the swimming pool? (Refractive index of water = 4/3)

N = $\frac{Real\ depth}{Apparent\ depth}$; $\frac{4}{3} = \frac{Real\ depth}{1.60}$; Real depth = $\frac{4 \times 1.6}{3}$ = 2.13 m

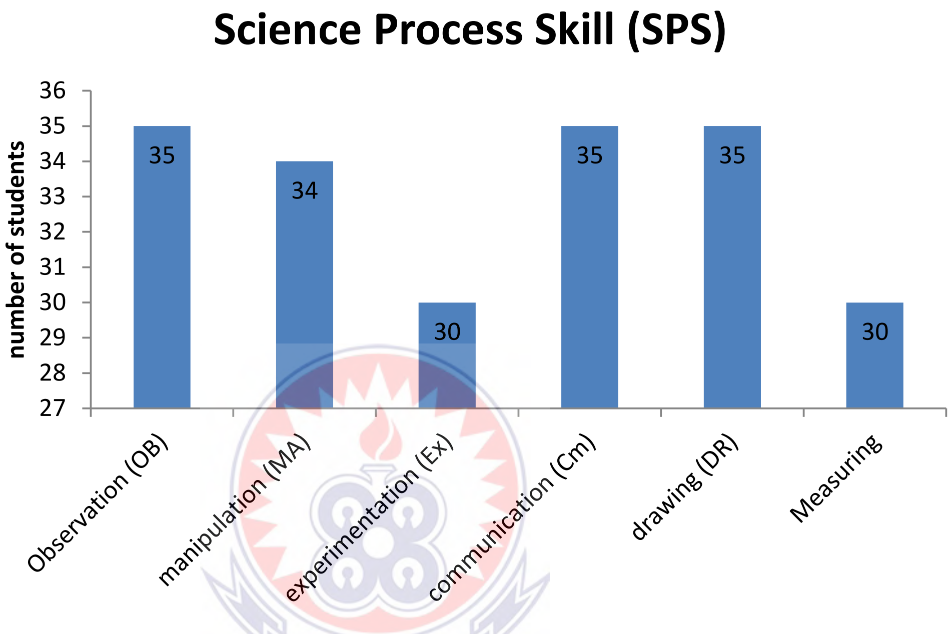


Figure 9: A graph of number of students exhibiting science process skills for activity 4

Table 7: Student's performance after practical

Themes	Total number of students	correct answers	partially correct answers	incorrect answers
Table	35	35(100%)	0	0
Scale	35	35(100%	0	0
Points plot	35	34(97.14%)	1(2.86%)	0
Slope	35	35(100%)	0	0
Precaution	35	35(100%)	0	0

Data from Table 7 showed that 35 (100%) of the students were able to construct the table of values correctly.

All the students were able find a scale for their values correctly.

Majority of the students, 34 (97.14%) of the students were able to plot their points accurately. About Two percent of the student, (1) exhibited partially corrected plotted points

All students were able to determine the slope of the graph correctly.

All the students, 35(100%) were able to state the precaution correctly.

Findings from lesson 4

The students focused and concentrated on the learning package and the manipulative materials. The following skills were demonstrated by the students in this lesson:

1. Students performed better in physics practical, work examples or activities when they were made to research for themselves.
2. Students were able to express their understanding freely about the concept learnt.
3. Eleven out of the 20 student representing 65% has problems in finding the scale of the graph since the values are decimal numbers.
4. Twelve students (60%) were not able to determine all the columns from the learning pack needed for the table
5. Manipulating skill was acquired when students (97.14%) place the paper on the drawing board and use thumb nails to hold it in position and also demonstrated in the placing of the pins on the incident and refracted rays.

6. Holding skill was acquired when the students held the prism in position in order to draw the outline of the prism.
7. Measuring skill**:** was demonstrated when the students measured the angles
8. Observing skill was acquired when 85.71% of the students observed the refracted pins on the other side of the prism and placed the pins in straight line.
9. Drawing skill was observed when the entire student (100%) draws the outline, refracted ray, incident ray, and the normal.
10. Communicating skill was acquired when 100% of the students tabulated four values of the period and the length. It was also displayed when they followed the Researchers' instructions and performed the tasked.

4.5 Report on Intervention Lesson 5 (five)

Topic: Experiment to verify ohm's law

Objective: After studying this package, students should be able to perform an experiment to verify ohm's law

1. **Relevant Previous Knowledge:** Students ask to mention some circuit components.

Some of the components of a circuit are resistor, ammeter voltmeter rheostat cell and key.

Activity one

Each student was given connecting wires, cell, key, rheostat, ammeter resistor box and voltmeter. Connect the circuit and close the key and adjust the rheostat until the current I through the ammeter is at maximum. Record the value of the current as I_0.

Adjust the rheostat S again until I = 0.5A. Read and record the value on the ammeter I and the value on the voltmeter V.

Activity two

Repeat the experiment with current I taking values of 0.8A, 1.1A 1.4A 1.7A and 2.0A, and in each case record the corresponding values of the voltmeter V. tabulate your reading. Plot a graph with current I as the ordinate and voltage V as the abscissa. Determine your slope of your graph.

Table 8: A sample Current and Voltage values

I /A	V_1/ V	V_2 / V	Mean V/V
0.5	0.9	1.0	1.0
0.8	1.6	1.6	1.6
1.1	2.2	2.2	2.2
1.4	2.8	2.8	2.8
1.7	3.4	3.4	3.4
2.0	4.0	4.0	4.0

How guided inquiry was used

The Researcher reviewed yesterday lesson about measurement of potential difference. The Researcher demonstrated the measurement of the voltage and the current of a dry cell. The students were able to read the values appropriately with units.

The Researcher accepts the values and introduces a new problem for the day. What are the factors that determine the amount of current passing through a conductor? Before you break into your various groups lets brainstorm on this problem.

Sir, the length of the wire. Kofi Said. So, what happen to the current if you use a very long wire or a short wire? The Researcher asked. The student answered by saying sir, the longer the wire, the higher the resistance, the less current flow. Does the that mean the length of the wire has something to do with the resistance? Yes sir.

Another student said, sir the resistance of the wire. Good, what happens to the resistance. The lower the resistance the higher the current. Another student said, sir the other factor is the potential difference across the wire. The Researcher said explain. Sir the current is directly proportional to potential difference. So, if the current is increasing the pd will also increase. The Researcher said am impress with your cooperation, you are now going to verify this experimentally.

The student break into their groups to start their experiments. Some started connecting the wires to the accumulator and other to the voltmeter and the ammeter. Members of each group took turns to manipulate with the materials given to them. Increase the current in each case to determine the corresponding voltage. They drew their table and plotted their graph. After 30 to 60 minutes return to their desk to report on their data and graph for each group.

The Researcher asks them to report starting from group two. Sir from our data we realised that the current increase as the voltage also increases. This conclusion was accepted by all the other groups. Another group also stated that slope of the graph is the resistance of the wire which also affects the current. The graph also starts from the origin. Rest of the groups supported their conclusion.

The Researcher concludes the lesson by summarising the factors that affects the current to be the voltage and the resistance.

Evaluations

1. State two precautions you took in performing this experiment

i. In order to prevent the accumulator from running down, I opened the key as soon as reading were taken

ii. Ensured that all connections were tight and secured in order to allow continuous flow of current

2. State ohm's law

Ohm's law states that the current passing through a metallic conductor is directly proportional to the potential difference between the ends provided physical conditions such as temperature and pressure remains constant.

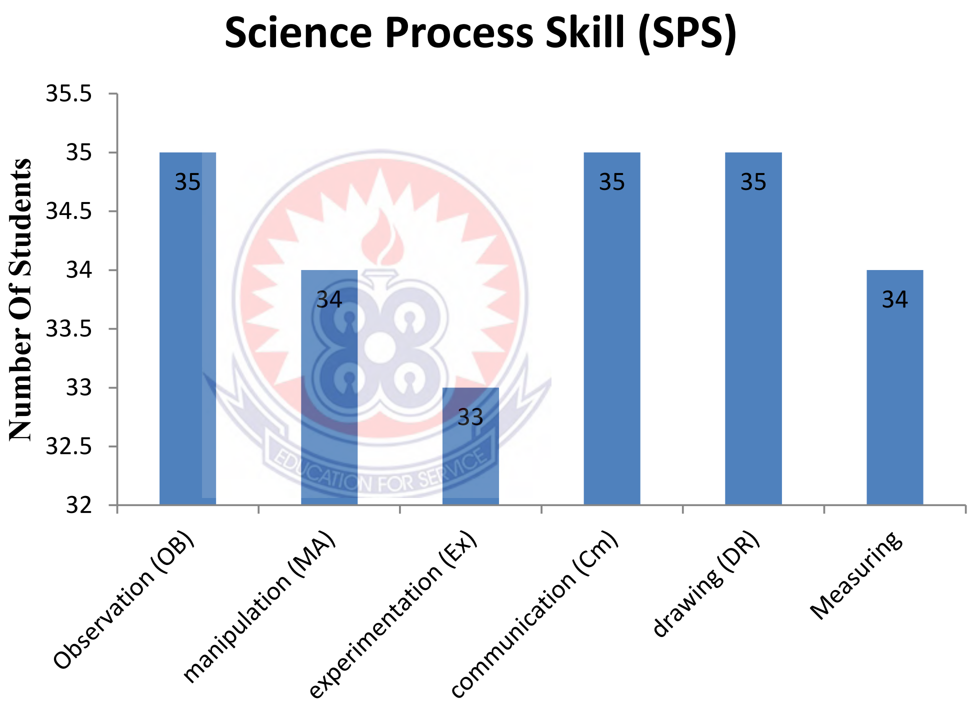


Figure 10: A graph of number of students exhibiting science process skills for activity 5

Table 9: Student's performance after practical

Themes	Total number of students	correct answers	partially correct answers	incorrect answers
Table	35	35(100%)	0	0
Scale	35	35(100%	0	0
Points plot	35	34(97.14%)	1(2.86%)	0
Slope	35	35(100%)	0	0
Precaution	35	35(100%)	0	0

Data from Table 9 showed that 35 (100%) of the students were able to construct the table of values correctly.

All the students were able find a scale for their values correctly.

Majority of the students, 34(97.14%) of the students were able to plot their points accurately. About Two percent of the student, (1) exhibited partially corrected plotted points

All students were able to determine the slope of the graph correctly. No one had and incorrect or partially correct slope.

All the students, 35(100%) were able to state the precaution correctly.

Findings from lesson 5

The students focused and concentrated on the learning package and the manipulative materials. The following skills were demonstrated by the students in this lesson:

1. Students' interest was aroused, and their attitudes towards learning were transformed, redirecting their preconception about physics as being a difficult subject and helping to improve their academic performance in physics.
2. Eleven (11) out of the 20-student representing 65% has problems in finding the scale of the graph since the values are decimal numbers
3. Manipulating skill was acquired when 35 students (100%) place the paper on the drawing board and use thumb nails to hold it in position.
4. Holding skill was acquired when the students held the prism in position in order to draw the outline of the prism.
5. Measuring skill: was demonstrated when 97.14% of the students measured the angles
6. Observing skill was acquired when all the students (100%) observed the refracted pins on the other side of the prism and placed the pins in straight line.
7. Drawing skill was observed when the students (100%) drew the outline, refracted ray, incident ray, and the normal.
8. Communicating skill was acquired when the students (100%) tabulated six values of the current I and voltage V. It was also displayed when they followed the Researchers‘ instructions and performed the tasked.

4.6 Practical and experimental skills (PES)

The practical and experimental skills (PES) involve the demonstration of the inquiry processes in science and refer to skills in planning and designing experiments, observation, manipulation, drawing, interpretation, recording reporting and conduct in the laboratory. Practical and experimental skills required in the effectiveness of practical scientific work are as follows;

Making observations and raising questions

The students were able to observe what their colleagues were doing to understand the experiments under investigation. They read and interpreted the learning pack, asked questions for more clarifications.

Conduction of experiment

The students were able to make measurements of time, temperature, angle, Voltmeter current and length and recorded them at their appropriate level or column. Proper use of instruments, equipment and materials (stopwatches, metre rule rheostat ammeter voltmeter thermometer protractor etc) including setting- up techniques and following safety guidelines

Analyse and interpret results

The students were able to represent the data in a form of a composite table, use a graph to analyse the data and get the relationship in the data. Identify reasons for inconsistent results such as the source of error or uncontrolled conditions. They were able to take precautions that help them to obtain accurate results.

Table 10: Science process skills demonstrated by students during the lessons

		Lessons					
N	Science Process Skill (SPS)	1	2	3	4	5	Total
1	Observation (Ob)	√	√	√	√	√	5
2	manipulation (MA)	√	√	√	√	√	5
3	Comparison (CA)	X	X	X	X	X	0
4	experimentation (Ex)	√	√	√	√	√	5
5	communication (Cm)	√	√	√	√	√	5
6	drawing (DR)	√	√	√	√	√	5
7	Measuring	√	√	√	√	√	5
8	Interpreting Data (ID)	√	√	√	√	√	5
9	Forming Hypothesis (FH)	X	X	X	X	X	0
10	Making Inference (MI)	√	√	√	√	√	5
11	Making Prediction (MP)	X	X	X	X	X	0

√ Science process skill observed, X = science process skill not observed

The table contained science process skills (SPS) that were demonstrated by the students in five Physics lessons. A tick (√) means a science process skill is observed and a cross (X) means a science process skill not observed. From the table, it is observed, that in lesson 1,2, 3 4 and 5 the science process skills (observation, Manipulation, Making Inference, experimentation, measuring Interpreting Data communication and drawing) were observed. The process science skills: observation, Manipulation, Making Inference, experimentation, measuring Interpreting Data drawing and communication were observed in lesson 4, as well as other lessons

4.7 Discussions

Research question 1: *what is the effect of guided inquiry instructional strategies on students" academicperformance in some selected topics in Physics?*

From the findings of lesson one, it was evident that most of the students were unable to answer questions in some selected topics in Physics correctly. Most of their wrong answers revealed specific misconceptions which need corrections. They also had poor practical skills and do not participate actively in Physics lessons.

In answering this question, the information gathered was based on conceptual understanding of Physics concepts and execution of practical skills. The classroom interactions that occurred within the five lessons were analysed.

Beginning with the finding of lesson 1, manipulating, holding, cutting, mounting, observing, and communicating skills were acquired by the students. Some of them (75%) were able to cut the thread on the retort stand and tie it against the pendulum bob and measure the length of the thread. 25% were unable to count a complete oscillation (cycle). In the process of oscillating, they press the stop watch to start and press it to stop after 20 oscillations. Communication skills were demonstrated when 45% of the students tabulated their results correctly. 55% of them were not able to get all the columns needed for the table, and omitted the decimal place of some quantities while others were able to do accurate work. Drawing skills, this posts some difficulties to the students because 60% of them have problems working with decimals, and finding scale.

In the finding of lesson 2, 89.28% of the students were able to carry out simple pendulum experiment. In this lesson, manipulation, cutting, mounting, observing, drawing, communication, and measuring skills were acquired by the students. It was noticed that there was improvement in the students manipulating, cutting, observing, measuring, and drawing. With manipulating (82.14%), cutting, and measuring skills (53.57%) of the students were able to cut and measure the length of the pendulum bob and mount it on the retort stand with the right measurement. Drawing skills, 92.86% of the students were able to draw the graph, get the reasonable scale, and correctly distinguished the axis. They were able to locate the exact the points of the data on the table. Communication skills, 96.43% of the students were able to tabulate their results correctly without missing columns, putting the correct decimal place (measure value to at least one or two decimal place and calculated value at least three significant figures) and putting the units correctly on the columns.

From the finding of lesson 3, manipulating, holding, drawing, observing, measuring, and communicating skills were demonstrated by the students. The students were able to weigh and record the masses of the empty calorimeter and its stirrer, and the calorimeter together with its content (hot water) to get the mass of the water. They were able to heat water on an electric heater and measure the temperature of the water up to 65 ^{0}. They observe the temperature by taking it every one minute until it continues to drop up to 35 ^{0}. They also heated kerosene while checking temperature up to 65 ^{0} and also transferred it into the calorimeter and keep records of its temperature every one minute. Communicating skills was experience when all the students (100%) kept their data into a table form and added the units with all the variables expected to be in there. Drawing skills was also exhibited when they drew the graphs on the same graph sheet. All the students inferred that the rate of cooling in water is slow as compared to that of kerosene

The finding of lesson 4, manipulation, observing, measuring, drawing and communicating skills demonstrated by the students. All the students (100%) were able to put the thump nails on the paper to hold it in position. They drew the outline of the rectangular prism and were able to trace the path of the incident ray and that of the refracted ray. 85.71% of the students measure the angles and calculated the sin*i* and sin *r* of the angles. They were able to plot the graph and communicate their data in the form table.

From the finding of lesson 5, manipulation, observing, measuring, drawing and communicating skills were acquired by the students. With manipulating 97.14% of the students interact with the connecting wires in other to connect the circuit. They were able to follow the diagram and connect appropriately. With the observing skills all the students (100%) were able to observe the readings of the voltmeter when the rheostat moves a bit. They also observed the reading of the ammeter. All the students communicated their results in a form of a table and were able to see the relationship between the current and the voltage. They drew their graph and saw a straight line from the origin.

Based on the quality of responses provided by the students during the lessons, it is clear that the guided inquiry methods have improved the students understanding of concepts and acquisition of practical skills. The findings of the study supported the study conducted by Galensstein (2004) who concluded that guided inquiry encourage independence, make learning memorable and increase students' academic achievement. This is also consistent with the findings of Mayer (2003) who concluded that guided inquiry encourages learners to search actively for how to apply rules and make sure that the learners come into contact with the rules to be learned. The findings are also in consonance with the results of Ugwanyi (2008) who noted that guided inquiry is more effective than the commonly use method.

Research question 2: *How do students" academic performances progress from lesson to lesson after they have been exposed to the guided inquiry method?*

This research question was answered by the academic performance of the students in responding to the questions asked and acquisition of skills during the five lessons. It was noticed that students' responses and acquisition of skills progressively improve form lesson 1 to 5.

Data from Table 1 showed that few students 3(13.3%) were able to construct the table of values correctly. Twenty-five percent of students comprising of 6 students partially got the table of values correctly. As many as 12(60.0%) of the students got the table of values wrong.

Thirty percent of the students consisting of 6 students were able find a scale for their values correctly. Few students, 2(10.0%) of the students were partially right. Majority of the students about 85.0% were incorrect. Few students, 3(15.0%) of the students were able to plot their points accurately. No student, 0 exhibited partially corrected plotted points. Seventeen students comprising of 85.0% got the question pertaining to plotted points incorrect. Minority of the students about 10% of the students were able to determine the slope of the graph correctly. Eighteen students comprising 90% of the students could not determine the slope of their graph correctly.

From Table 3 showed that majority of the students 15(53.57%) were able to construct the table of values correctly. Twenty-five percent of students comprising of 7 students partially got the table of values correctly. Few students 6(21.43%) got the table of values wrong.

Seventy-one percent of the students consisting of 20 students were able find a scale for their values correctly. Few students, 5(17.86%) of the students were partially right. Very few of the students about 10.71% were incorrect. Majority of the students, 17(60.71%) of the students were able to plot their points accurately. Fourteen percent of the student, (4) exhibited partially corrected plotted points. Seven students comprising of 25.0% got the question pertaining to plotted points incorrect. Majority of the students about 67.86% of the students were able to determine the slope of the graph correctly. Nine students comprising 32.14% of the students could not determine the slope of their graph correctly.

In Table 5, 35(100%) of the students were able to construct the table of values correctly. None of the students got the table either incorrect or partially correct. Ninety-one percent of the students consisting of 33 students were able find a scale for their values correctly. None of the students were partially right and very few of the students about 2.71% were incorrect. Majority of the students, 30(85.71%) of the students were able to plot their points accurately. Eleven percent of the student, (4) exhibited partially corrected plotted points while one (1) student comprising of 2.86% got the question pertaining to plotted points incorrect. Majority of the students about 97.14% of the students were able to determine the slope of the graph correctly. One (1) student comprising 2.86% got it partially correct. All the students, 35(100%) were able to state the precaution correctly. None of the students got the precaution partially correctly or incorrect.

Data from Table 7 showed that 35(100%) of the students were able to construct the table of values correctly. None of the students got the table either incorrect or partially correct. All the students were able find a scale for their values correctly. None of the students were partially right or incorrect. Majority of the students, 34(97.14%) of the students were able to plot their points accurately. Two percent of the student, (1) exhibited partially corrected plotted points while no comprising plotted incorrect points. All students were able to determine the slope of the graph correctly. No one had and incorrect or partially correct slope. All the students, 35(100%) were able to state the precaution correctly. None of the students got the precaution partially correctly or incorrect. Most of the students, 22(78.57%) were able to state the precaution correctly. Minority of the students, 5(17.86%) got the precaution partially correctly.

Data from Table 9 showed that 35(100%) of the students were able to construct the table of values correctly. None of the students got the table either incorrect or partially correct. All the students were able find a scale for their values correctly. None of the students were partially right or incorrect. Majority of the students, 34(97.14%) of the students were able to plot their points accurately. Two percent of the student, (1) exhibited partially corrected plotted points while no comprising plotted incorrect points. All students were able to determine the slope of the graph correctly. No one had and incorrect or partially correct slope. All the students, 35(100%) were able to state the precaution correctly. None of the students got the precaution partially correctly or incorrect.

The progressive increased in concepts and skills acquisition by the students indicates that guided inquiry instructional package is effective for teaching and learning of Physics. This result is consistent with the findings of Sutherland and Wehby (2001) who asserted that students who are actively engaged and are provided with frequent opportunity to respond to academic tasks demonstrate improved academic skills and performance. The results is also consistent with the findings of Lukose and Mammen, (2018) which indicated that significant gains in academic achievements for the experimental group(guided inquiry) over those in the control group. The findings of this study also conferred with that of Saba, Bayero and Abubakar findings which stated that, inquiry teaching method among secondary school students was found to be highly efficient in improving academic performance of these wards. It was also observed that in the study that inquiry method of instruction produced same positive effect on both urban and rural students who were exposed to it unlike the lecture method. Arikewuyo, Olabiyi, and Malik (2020) also established that usage of guided inquiry approach can facilitate learning when it is properly adopted by the teacher to teach Further Mathematics. Also, students can think critically to bring about desirable result and outcome that will go a long way to enhance their performance in Further Mathematics and other Science related subjects.

The results of the finding is consistent with the finding of which all points to the fact that guided inquiry instructional package is effective for teaching and learning (Awan, Kanwal, and Qamar, 2021; Rufai, 2016; Al Zarooni, 2014; Eebo, 2020; and Wangdi, Precharattana, and Kanthang, 2020)

Research question 3: *What effects do guide inquiry methods have on students" attitudes toward Physics?*

Observational checklist was used to gather information for this question. Before the introduction of the guided inquiry method the student‘s attendance to class and involvement in Physics lessons was unsatisfactory (number of students in lesson 1 in Table 1 is 20, the number increase to 28 in lesson 2 in Table 3 and 35 in lesson 3, 4 and 5 respectively). However, during and after the intervention the Researcher observed the students are now active participant and regular in lessons, always write down notes on their own and were able to perform their practical within the time frame. In lesson 5 they were very happy to verify Ohm‘s law. This motivated them to draw the graph and found that it is actually a straight line from the origin. This is a clear indication that guided inquiry method has positive effects on student‘s attitudes toward Physics. Ural (2016) findings have revealed that as a result of the applications of guided inquiry, there has been a significant increase in students' attitudes towards chemistry laboratory, and their academic achievement and a decrease in their chemistry laboratory anxiety. Koksal and Berberoglu (2014) also stated that guided inquiry enhanced the experimental group students' understandings of the science concepts as well as the inquiry skills more than the control group students. Similarly, the experimental group students improved their attitudes toward science more than the control group students as a result of treatment. Nwagbo (2006) showed that the guided inquiry method was significantly better than the expository method in enhancing cognitive achievement in biology for students of all levels of scientific literacy, especially the high ones. Students of different levels of scientific literacy showed positive attitude to biology, when the two methods were used. The interactive effects of teaching methods and scientific literacy levels, on both achievement in and attitude to biology. Yager and Akcay (2010) indicated that student understanding of science skills and concepts in the inquiry sections increased significantly more than they did for students enrolled in typical sections in terms of process skills, creativity skills, ability to apply science concepts, and the development of more positive attitudes. Wihardjo, Nurani, and Ramadhan, (2020), concluded that learning process by using guided discovery model effectively improve cognitive competencies, meticulous attitudes and psychomotor skills. Based on the average score and comparative test experimental group and the control group for cognitive competence and meticulous attitude, it tends to be more effective when applied Model Guided discovery than the conventional model, while for the psychomotor skills show a similar result (not significantly different) between experiment and control groups. Pratiwi, Makhrus, and Zuhdi (2021) results showed that the learning media based on the guided inquiry learning can effectively improve students' science literacy skills and scientific attitudes during the learning process in the material of Momentum and Impulse.

From the above findings, it shows that guided inquiry method has positive effects on student's attitudes, which is also the findings of this study.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Overview

In this chapter the summaries of the findings of the study have been documented. There were seven findings that emerged out of the intervention lessons. In concluding the work, it is stated that the guided inquiry strategies have the potential of enhancing students' academic performance. In this study it was observed that though only five lessons were given, there was quite an appreciable gain in students' learning and answers to questions as the guided inquiry strategies were used. This is an indication that if there was enough time to extend the teaching and learning approach used, the students would have made substantial gains in learning.

5.1 Summary of findings

There were seven findings in this study which spanned five Physics lessons on some selected topics. The following were the findings that emerged from the study:

1. The use of groups in teaching physics had greatly improved students' conceptual understanding physics.
2. Employing guided inquiry strategies during classroom discourse made students active and attentive in class as the class was interactive.
3. Appropriate feedbacks given to students questions spurred students on to ask more relevant questions
4. Involving the students during lessons made them feel being part of the class and therefore influenced their understanding of concepts positively.
5. Students perform better in physics practical, worked examples or activities when they are made to research for themselves.

6. Students were able to express their understanding freely about the concept learnt.
7. The implementation of guided inquiry method into the teaching and learning process had really helped to arouse students' interest, transformed their attitudes towards learning, redirected their preconception about physics as being a difficult subject and helped improved their academic performance in physics.

5.2 Conclusion

On the basis of the results obtained in the study, it is concluded that guided inquiry method of teaching is capable of improving students' academic performance in some selected topics in Physics. Moreover, the strategies make classroom more realistic as students are more actively involved and make them responsible for their own learning. Carefully planned lessons encourage, motivate, reduce disruptive behaviour, promote positive effects on mutual concern and care among students. Also from this study, it can be inferred that guided inquiry strategies fosters the development of practical skills such as manipulating, observing, comparing, communicating, measuring, drawing and inference which is intended to stimulate healthy intellectual climate for students to interact effectively with each other with minimal friction. However, without proper planning and guidance, the opportunity to inculcate the acquisition of science process skills might not occur. If teachers take the attitude that the students will get it eventually in a science class, the goal of science teaching might not be achieved. Science teaching should be planned and done alongside with the aim of inculcating science process skills in the students and to ensure their acquisition.

5.3 Recommendations

In the light of the results, the following recommendations are made for science teachers and school administrators:

1. Planning of lessons enables teachers to acquire teaching equipment so teachers may take cue from the way the lessons were planned in this work.
2. Teachers may empower and motivate students to be responsible for their own learning by creating opportunities that will actively involve them in the learning process. This may help them discover knowledge, concepts and relations in the texts.
3. Guided inquiry approaches could be implemented for different types of students. Science teachers may consider students' individual differences and make the class a suitable environment for all students to participate in the classroom activities.
4. Students with special needs might need different strategies to keep them on track. In this research, there were students who preferred to work alone.
5. School administrators may facilitate teachers' missions by providing them with worksheets needed for their lessons and the available internet services to enable them search for methodology issues.

5.4 Suggestions for Further Research

The findings of this study showed that guided inquiry activities can improve students' practical skills; it is therefore suggest that students should be given more practical activities to do to reinforce the theory lessons. Teachers should always give exercises to students to improve their skills as evident in this study. The same work can be given to the students twice and the result compared to find out whether there is improvement or not.

This study examined improvement of school academic performance in Physics at the SHS level in Jaman North in the Bono region in Ghana, further studies can be conducted to investigate the effectiveness of guided inquiry in other disciplines, in urban, in rural, in suburban schools, and for high, average, and low achievers.

REFERENCES

Adesoji, F.A. (2008). Student, Teacher and School Environmental Factors and Determinants of Achievement in Senior Secondary School Chemistry in Oyo State, Nigeria.*Journal of International Social Research,* l(2)

Adesokan, C.O. (2002). *Students Attitude and Gender as Determinants of Performance in JSS Integrated Science*.Unpublished Project. Department of Chemistry, University of Nigeria Nssuka . 15(3) 21-22

Afolabi, F., & Akinbobola, A. O. (2009). Constructivist problem based learning technique and the academic achievement of physics student with low ability level in Nigerian secondary schools. *Eurasian Journal of Physics & Chemistry Education, 1,* 45-51.

Agboola, O. S., & Olabimpe, H. J. (2017). Effects of physical and virtual laboratory experimentation on students‘learning outcomes in basic science in ife central local government area, osun state. *Journal of Curriculum and Instruction*, *10*(2), 48-53.

Airasian, P. W. (2000). *Assessment in the classroom: A concise approach*. McGraw-Hill, 1221 Avenue of the Americas, New York.

Akinbobola, A. O. (2015). Effects of learning styles and instructional strategies on students‘ achievement in Nigerian senior secondary school physics. *Advances in Physics Theories and Applications*, *41*(1), 20-29

Akinbobola, A. O. (2009). Enhancing students‘ attitude towards Nigerian Senior Secondary School Physics through the use of cooperative, competitive and individualistic learning strategies. *Australian Journal of Teacher Education, 34*(1), 166-167.

Akinmoyewa, J. O. (2003). Effects of cooperative, competitive and individualistic use of self-instructional package on Learners‘ Achievement in Biology. *Journal of Education and Society, 1*(2), 133-141.

Al Zarooni, B. E. A. R. (2014). Impact of guided inquiry on tenth graders‘understanding of chemical bonds.

Allen, D., & Tanner, K. (2005). Infusing active learning into the large-enrollment biology class: seven strategies, from the simple to complex. *Cell biology education*, *4*(4), 262-268

Amedahe, F. K. (2002). *Fundamentals of educational research methods.* Cape Coast: University of Cape Coast.

Amoani, K. (2005). *Research methodology and review*. Accra: Pentecost Press.

Anderson, T., & Fretzin, L. (2004). *Programmed instruction*. Retrieved June 8th, 2022 from http://lrs.ed.uiuc.edu/students/fretzin/epl1q2programmed.htm.

Angyaye, C.O. (2007). *Information and Communication Technology*.A Platform Credible Examination in Nigeria. A Paper Presented at the Conference on Examination Security in Nigeria held in Abuja p10. Baja, T.S. (1976). Natural Science Subjects and Career Choice.*Journal of Science Teacher Association of Nigeria*, 15(1), 345-349

Annum, G. (2015). *Research instruments for data collection*. Retrieved on June 9th, from campus.educadium.com./newmdiart/file.../ugraResearch/…/resinstr

Arikewuyo, D. S., Olabiyi, M. O., & Malik, N. A. (2020). influence of guided inquiry approach on students‘performance in further mathematics at senior secondary schools in lagos STATE, NIGERIA. *Abacus (Mathematics Education Series)*, *45*(1), 223-226

Ary, J. & Razaviet, B. (2002). *Research in education*. London: Wadswork Group.

Atkinson, P., & Delamont, S. (2017). Mock-ups and cock-ups: The stage-management of guided discovery instruction. *In School experience* 60(3), 87-108

Berding, J. W. A. (2000). *John Dewey"s participatory philosophy of education: Education, experience and curriculum.* Retrieved on 17th June 2022 from http://www.socsci.kun.nl/ped/whp/histeduc/misc/dewey01.html

Bernard, H. R. (2002). *Research methods in anthropology: Qualitative and quantitative methods* (3rd ed.). Walnut Creek, California: Alta Mira Press.

Bichi, S.S (2002). *Effects of Problem Solving Strategy and Enriched Curriculum on Secondary School Students* Achievement in Evaluation Concepts.Unpublished Ph.D. dissertation, A.B.U Zaria.

Bilgin, I. (2006). The effect of hands on activities incorporating in a cooperative learning approach on eighth grades students‘ science process skills and attitudes towards science. *Journal of Baltic Science Education, 9*(1), 27- 37.

Bimbola, O. (2010). *Effects of Constructivist-based Teaching Strategy on Academic Performance of Students in Integrated Science at the Junior Secondary Level*.IjebuOde, Ogun state Nigeria.

Bjorklund, D. F. (2000). *Children's thinking: Developmental function and individual differences* (3rd ed.). Belmont: Wadsworth/Thomson Learning.

Boase, N., White, M., Gaze, W., & Redshaw, C. (2017). Evaluating the mental models approach to developing a risk communication: a scoping review of the evidence. *Risk analysis*, *37*(11), 2132-2149

Bogdan, R. C., & Bilklen, S. K. (2003). *Qualitative research for education: An introduction to theory and methods* (4th ed.). Boston: Allyn & Bacon.

Brophy, J. (2003). *Teaching problem students*. Guilford Press

Brookfield, S. (2000). Adult cognition as a dimension of lifelong learning. *Lifelong learning: Education across the lifespan*, 89-101

Capps, D. K., Crawford, B. A., & Constas, M. A. (2012). A review of empirical literature on inquiry professional development: Alignment with best practices and a critique of the findings. *Journal of science teacher education*, *23*(3), 291-318

Castillo, J.J. (2009). *Research population*. Retrieved on 28rd July, 2022 from http://www.experiment-resources.com/research-population.html

Castronova, J. A. (2002). Discovery learning for the 21st century: What is it and how does it compare to traditional learning in effectiveness in the 21st century. *Action research exchange*, *1*(1), 1-12

Cepni, S. (2010*). Introduction to Research and Studies Project*. Trabzon: Celepler Printing.

Chen, C. H., & Yang, Y. C. (2019). Revisiting the effects of project-based learning on students' academic achievement: A meta-analysis investigating moderators. *Educational Research Review*, *26*, 71-81

Cohen, L., Manion, L., & Morrison, K. (2008). *Research methods in education.* New York: Routledge.

Colley, K. E. (2006). Understanding ecology content knowledge and acquiring science process skills through project based instruction. *Science Activities, 43*(1), 26-33.

Craik, F. I. (2020). Remembering: An activity of mind and brain. *Annual Review of Psychology*, *71*, 1-24.

Creswell, J. W. (2008). *Educational research: planning, conducting, and evaluating quantitative and qualitative research* (3rd ed.). New Jersey: Upper Saddle River.

Darwin, C. (2017). Building a learning organization. *Knowledge Solutions*, *57, 67-73*

Deboer, G.E. (2002). Student Centered Teaching in a Standard-Based World: Finding Sensible Balance. *Science and Education*, 11(4), 405-417.

Dewar, M. T., Cowan, N., & Della Sala, S. (2007). Forgetting due to retroactive interference: a fusion of early insights into everyday forgetting and recent research on anterograde amnesia. *Cortex; a journal devoted to the study of the nervous system and behavior*, *43*(5), 616.

Dillon, J. (2000). *Classroom questions and discussions.* Norwood, NJ: Ablex.

Donald, A.B. (2000). *What is the Use of Lecture*

Donat, E., Brandtweiner, R., & Kerschbaum, J. (2009). Attitudes and the digital divide: Attitude measurement as instrument to predict Internet usage. *Informing Science*, *12*, 37

Dudley, P. (2011). Lesson Study development in England: from school networks to national policy. *International journal for lesson and learning studies*. 54(5), 446-449

Dusick, D. M. (2011). *Writing the delimitations*. http://bold-ed.com/delimitations.htm.

Ekpete, D. (2002). Learning Value of Wireless Mobile Device. *Journal of Computer Assisted Learning, 19(3), 260-272*

Ellington, A. J. (2003). A meta-analysis of the effect of calculators on students' achievement and attitude levels in-college mathematics classes. *Journal for Research in Mathematics Education, 34*(5), 433-463.

Felder, R. M., & Brent, R. (2004). The intellectual development of science and engineering students. Part 1: Models and challenges. *Journal of Engineering Education*, *93*(4), 269-277

Ferrance, E. (2000). *Action research –education theme, national and Island Regional Educational Laboratory, Brown University.*49(7), 47

Ferri, F., Grifoni, P., & Guzzo, T. (2020). Online learning and emergency remote teaching: Opportunities and challenges in emergency situations. *Societies*, *10*(4), 86

Festus, C. (2007). *Towards Effective Learning; for Learners*.Tower Gate Resources, Harcourt, Nigeria. P82-102

Fisher, C. D. (2010). Happiness at work. *International journal of management reviews*, *12*(4), 384-412

FitzGerald, L. (2011). The twin purposes of guided inquiry: guiding student inquiry and evidence based practice. *Scan: The Journal For Educators*, *30*(1), 26-41

Fraenkel, J. R., & Wallen, N. E. (2000). *How to design and evaluate research in education* (4th ed.). New York: McGraw-Hill,Inc.

Friesen, S., & Scott, D. (2013). Inquiry-based learning: A review of the research literature. *Alberta Ministry of Education*, *32, 1-32*

Gamble, J. (2010). Teacher professionalism: A literature review. *Johannesburg: JET Educational Services. Accessed November*, *16*, 20-24

Gilbert, S. W. (2011). *Models-based science teaching: Understanding and using mental models*. NSTA Press

Glass, J., Hazen, T. J., Cyphers, S., Malioutov, I., Huynh, D., & Barzilay, R. (2007). Recent progress in the MIT spoken lecture processing project. In *Eighth Annual Conference of the International Speech Communication Association*

Glenng, R.E. (2001). *What teachers need to be the Education Digest*, 67(1), 19

Good, T. &Brophy, J. (1994). *Looking in Classrooms*, 6thed, New York: Harper Publishers.

Gopalan, V., Bakar, J. A. A., & Zulkifli, A. N. (2017, October). A brief review of augmented reality science learning. In *AIP Conference Proceedings* (Vol. 1891, No. 1, p. 020044). AIP Publishing LLC.

Greenwald, E. (2002). *Teaching and Learning with Cases:* New York Chatham House Publishers.

Gunasinghe, A., Abd Hamid, J., Khatibi, A., & Azam, S. F. (2019). Academicians' acceptance of online learning environments: A review of information system theories and models. *Global Journal of Computer Science and Technology*, *19*(1), 31-39

Hannula, M. S. (2002). Attitudes toward mathematics and science. Emotions and expectations values. *Education studies in Mathematics, 49*, 25-46.

Hardy, I., Jonen, A., Moller, K., & Stern, E. (2006). Effects of instructional support within constructivist learning environments for elementary school Students‘ understanding of ―floating and sinking". *Journal of Educational Psychology, 98*(2), 307-326.

Hussain, A., Azeem, M., & Shakoor, A. (2011). Physics teaching methods: scientific inquiry vs traditional lecture. *International journal of humanities and social science*, *1*(19), 269-276.

Ibrahim, A. I, Hamidu, M. Y, & Mohammed, A. (2014). The use of laboratory method in teaching secondary school students: A key to improving the quality of education. *International Journal of Scientific & Engineering Research*, *5*(9), 81-86.

Jack, F. R., & Norman, E. W. (2003). *How to design and evaluate research in education* (5th ed.). Boston: McGraw Hill Publishers.

Jackson, K. M., & Trochim, W. M. (2002). Concept mapping as an alternative approach for the analysis of open-ended survey responses. *Organizational research methods*, *5*(4), 307-336.

Jo, R. (2010). *The Logic of discovery of grounded theory*: Sage. Retrieved June 21th, 2022 from http://srmo.sagepub.com/../nio.xml

Johnson, D. W., Johnson, R. T., & Smith, K. (2007). The state of cooperative learning in postsecondary and professional settings. *Educational Psychology Review*, *19*(1), 15-29.

Jomaa, L. H., McDonnell, E., & Probart, C. (2011). School feeding programs in developing countries: impacts on children's health and educational outcomes. *Nutrition reviews*, *69*(2), 83-98

Kay, R.H. (1990). Predicting Student Teacher Commitment to the use of Computers, *Journal of Educational Computing Research, 6, 299-309. Service No. ED318912*

Kearsley, G. (2001). *Constructivist theory: Theory into practice.* Jacksonville, FL: Jacksonville State University.

Ketpichainarong, W., Ruenwongsa, P., & Panijpan, B. (2009). Enhancing Student Conceptualization of Enzyme Activity Using a Cellulose Digesting Enzyme: An Inquiry-Based Approach. *International Journal of Learning*, *16*(2), 23-28

Khan, R. E. (2010). *Developing the theoretical and social framework, Lecture J199.* http://www.scribd.com/patrisya123/documents.

Kidman, L. (2001). *Developing decision makers. An empowerment approach to coaching christ church*. New Zealand: Innovative Print Communications Ltd.

Kim, (2005). *"Effects of a Constructivist Teaching Approach on Student Academic Achievement, Self-concept, and learning strategies*" Asia pacific Education Review 6(1), 7-19.

Kimoto, T. (2015). Material science and device physics in SiC technology for high-voltage power devices. *Japanese Journal of Applied Physics*, *54*(4), 40-48

Kivunja, C. (2014). Theoretical perspectives of how digital natives learn. *International Journal of Higher Education*, *3*(1), 94-109

Koksal, E. A., & Berberoglu, G. (2014). The effect of guided-inquiry instruction on 6th grade Turkish students' achievement, science process skills, and attitudes toward science. *International Journal of Science Education*, *36*(1), 66-78.

Kukulska-Hulme, A., & Viberg, O. (2018). Mobile collaborative language learning: State of the art. *British Journal of Educational Technology*, *49*(2), 207-218

Kumekpor, T. K. B (2002). *Research methods and techniques of social research.* Accra: SonLife Press & Services.

Labaree, D. F. (2011). The lure of statistics for educational researchers. *Educational Theory*, *61*(6), 621-632

Lawrence, A. & Abraham, C.O. (2011). Development of science process skill instruction. *Journal of Research in Science Teaching 26,715-726*

Lazonder, A. W., & Harmsen, R. (2016). Meta-analysis of inquiry-based learning: Effects of guidance. *Review of educational research*, *86*(3), 681-718.

Llewellyn, D. (2005). *Performance, Measurement and Evaluation*.Retrieved on 17t February, 2022 from http://www.freedomscientific.com/ISG.html.

Lukose, J., & Mammen, K. J. (2018, December). Enhancing academic achievement in an introductory computer programming course through the implementation of guided inquiry-based learning and teaching. In *Asia-Pacific Forum on Science Learning & Teaching* (Vol. 19, No. 2).

Mahaboobjan, A. (2010). *Research methodology in Physical Education*. Delhi: Kalpaz publications.

Mansour, N. (2009). Science teachers' beliefs and practices: Issues, implications and research agenda. *International Journal of Environmental and Science Education*, *4*(1), 25-48

Marsh, J. (2010). *Childhood, culture and creativity*. *London:* Creative Partnerships, Arts Council England.

Mayer, R.E. (2003). *Learning and instruction*. Upper Saddle River: Pearson Education Inc.

Mayer, R. (2004). Should there be a three-strike rule against pure discovery of learning? The case for guided methods of instruction. *American Psychologist 59* (1), 14-19.

Mezieobi, D. I. (2008). Social Studies education as an instrument for building sustainable democratic values in Nigeria. *Journal of Cultural Studies*, *1*, 45-57

McCarney, R., Warner, J., Iliffe, S., Van Haselen, R., Griffin, M., & Fisher, P. (2007). The Hawthorne Effect: a randomised, controlled trial. *BMC medical research methodology*, *7*(1), 1-8.

McCormack, J., Johns, K., & Tildesley, H. (2005). Metformin's contraindications should be contraindicated. *Cmaj*, *173*(5), 502-504.

McLeod, S. A. (2012). Zone of Proximal Development.

Mezieobi, K. A; Fubara, V. R &Mezieobi S.A. (2008).*Social Studies in Nigeria Teaching Methods.Instructional Material and Resources*.Acadabeak Publishers 21 Erekwerenwa Street, Owerri, Nigeria p24-29.

Mills, G. E. (2000). *Action research: A guide for the teacher Researcher.* Columbus: Prentice Hall

Mogari, D. (2003). A relationship between attitude and achievement in Euclidean geometry of grade 10 pupils. *African Journal of Research in Mathematics, Science and Technology Education*, *7*(1), 63-72.

Musingafi, M. C. C., & Muranda, K. E. (2014). Students and questioning: A review of the role played by students generated questions in the teaching and learning process. *Studies in Social Sciences and Humanities*, *1*(3), 101-107

National Research Council. (2000). *National science education standards*. Washington, D.C.: National Academy Press

Navarro, M., Förster, C., González, C., & González-Pose, P. (2016). Attitudes toward science: Measurement and psychometric properties of the Test of Science-Related Attitudes for its use in Spanish-speaking classrooms. *International Journal of Science Education*, *38*(9), 1459-1482

Nevid, J. S. (2021). Essentials of psychology: Concepts and applications Columbus: Prentice Hall

Nkheleh P. (1993). Pictorial Problem Solving in Chemistry. *Journal of Chemical educational books Nigeria Ltd* p12-40

Nwagbo, C. (2006). Effects of two teaching methods on the achievement in and attitude to biologyof students of different levels of scientific literacy. *International Journal of Educational Research, 45*, 216-229.

Oladapo, (2008).*Lecturing: Advantages and Disadvantages of the Traditional Lecture Method.*University of Illinoise-urbana Champaign.p90-98

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International journal of science education*, *25*(9), 1049-1079

Özdilek, Z., & Bulunuz, N. (2009). The effect of a guided inquiry method on pre-service teachers‘ science teaching self-efficacy beliefs. *Journal of Turkish science education*, *6*(2), 24-42.

Parson, R. D., & Brown, K. S. (2002). *Teacher as a reflective practitioner and action Researcher.* Belmo nt, Calif: Wadsworth &Thomson learning.

Pedaste, M., Mäeots, M., Siiman, L. A., De Jong, T., Van Riesen, S. A., Kamp, E. T., ... & Tsourlidaki, E. (2015). Phases of inquiry-based learning: Definitions and the inquiry cycle. *Educational research review*, *14*, 47-61

Petty, J. (2013). Interactive, technology-enhanced self-regulated learning tools in healthcare education: A literature review. *Nurse education today*, *33*(1), 53-59

Polman, J. L., & Pea, R. D. (2001). Transformative communication as a cultural tool for guiding inquiry science. *Science Education*, *85*(3), 223-238.

Popooola, A. A. (2002). *Effect of Heuristic problem solving and programmed instructional strategies on senior secondary school students" learning outcomes in mathematics and science in Ekiti State, Nigeria.* Unpublished Ph.D Thesis, University of Ibadan.

Prince, M. J., & Felder, R. M. (2006). Inductive teaching and learning methods: Definitions, comparisons, and research bases. *Journal of engineering education*, *95*(2), 123-138

Punch, K. F. (2006). *Developing Effective Research Proposals* (2nd ed.). London Sage Publication Ltd.

Raimi S.M. (2002). *Problem-Solving Technique and Laboratory Teaching in Senior Secondary School Students.* unpublished PHD Thesis University of Ibadan.

Ramanathan, G., Carter, D., & Wenner, J. (2022). A Framework for Scientific Inquiry in Preschool. *Early Childhood Education Journal*, *50*(7), 1263-1277

Reichert, R. (2005). *Scientific discovery learning with computer simulations of conceptual domains of learning.* Retrieved on June 14, 2022 from www.elearning reviews.org/publications/270 HTML Dillon, j.

Robson, C. (2002). *Real World Research* (2nd ed.). Singapore: Best-Set Tyesetter Ltd.

Rufai, M. D. (2016). *Effects Of Problem-Solving and Guided Inquiry Strategies On Senior Secondary Students „learning Outcomes in Biology In Ibadan*. unpublished PHD Thesis University of Ibadan

Rutten, N., Van Joolingen, W. R., & Van Der Veen, J. T. (2012). The learning effects of computer simulations in science education. *Computers & education*, *58*(1), 136-153

Saat, R. M. (2004). The acquisition of integrated science process skills in a web – based learning environment. *Research in Science Teaching and Technological Education, 22*(1), 23 –40.

Saeed, K.M, (2011). Effects of Inquiry Method on Achievement of Students in Chemistry at Secondary School Level. *International Journal of Academic Research;* l3(1), 55.

Seawright, J., & Gerring, J. (2008). Case selection techniques in case study research: A menu of qualitative and quantitative options. *Political research quarterly*, *61*(2), 294-308.

Seidu, A. (2007). *Modern approaches to research in educational administration*. Kumasi: Payless Publication Limited.

Sevilay, C. (2004). *Effects of Inquiry-based Chemistry course on Students Understanding of Atom Concept, Learning Approaches, motivation, Self-Efficacy, and Epistemological Beliefs.* A Thesis submitted to the graduate School of natural and applied sciences of the middle east Technical University.

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference.* New York: Houghton Mifflin Company.

Shuttleworth, M. (2008). *Quasi-Experimental Design*. Retrieved on June 8, 2023 from www.elearning reviews.org/publications/270 HTML Dillon, Simon, M. K., & Goes, J. (2011). Developing a theoretical framework. *Seattle, WA: Dissertation Success, LLC*, 13-18.

Sola, A.S. &Ojo, E. (2007). Effect of project, Inquiry and Lecture-Demonstration Teaching method on Achievement on Senior Secondary Student in Separation of Mixtures practical test*. Educational research and review* 2(6), 124-134.

Spackman, J. S., & Yanchar, S. C. (2014). Embodied cognition, representationalism, and mechanism: a review and analysis. *Journal for the Theory of Social Behaviour*, *44*(1), 46-79

Steeples, C. (2004). *Using action-oriented or participatory research methods for research on networked learning", Networked Learning Conference, NCL Proceedings, Symposium*

Tam, M. (2014). Outcomes-based approach to quality assessment and curriculum improvement in higher education. *Quality assurance in education*, *22*(2), 158-168

Tang, Y. Y., Yang, L., Leve, L. D., & Harold, G. T. (2012). Improving executive function and its neurobiological mechanisms through a mindfulness-based intervention: Advances within the field of developmental neuroscience. *Child development perspectives*, *6*(4), 361-366

Taraban, R. (2007). Effect of active learning experiences. *Journal of Research and Science Teaching, 44* (7), 960-979

Thornbury, S. (2004). *How to introduce new language "Natural English, teacher development.* http://www.oup.com/elt/teacher/naturalenglish.

Tilley, P. A. (2005). Lean design management-A new paradigm for managing the design and documentation process to improve quality?. *Proceedings IGLC-13*

Trochim W. M. K. (2006). *Research methods knowledge based*. http://www.socialresearchmethods.net/kb/design.php.

Trowbridge, L.W. (2000). *Teaching Secondary School Science*, Upper Saddle River, NJ: Merrill/Prentice Hall

Turri, J. (2017). Experimental work on the norms of assertion. *Philosophy Compass*, *12*(7), 124-125

Udousoro, U. J. (2002). The relative effects of computer and text-assisted programmed instruction on students‘ outcomes in mathematics. *Unpublished Ph. D. Thesis, University of Ibadan*.

Ugwanyi, J. A. (2008). Effect of guided discovery achievement in physics in selected secondary schools. *Nigeria Journal of Technical Education*, *15*(1) 167- 171.

Ugwu, O., & Soyibo, K. (2004). The effects of concept and vee mappings under three learning modes on Jamaican eighth graders' knowledge of nutrition and plant reproduction. *Research in Science & Technological Education*, *22*(1), 41-58.

Ural, E. (2016). The Effect of Guided-Inquiry Laboratory Experiments on Science Education Students' Chemistry Laboratory Attitudes, Anxiety and Achievement. *Journal of Education and Training Studies*, *4*(4), 217-227.

Usman, I.A. (2000). *Relationship between Students Performance in Practical Activities and their Academic Achievement in Integrated Science Using the NISTEP Mode of Teaching.* Unpublished Ph.D, Thesis, A.B.U Zaria.

Usman, I.A. (2006). *Strategies for Conducting Practical in Science, Technology and Mathematics.*A Lead Paper Presented at STAN Workshop at Federal Government Girls College Malali, Kaduna.

Walsh, J., & Sattes, B. D. (2005*). Quality questioning: Research-Based practice to engage every learner.* Thousand Oaks, CA: Corwin press.

Warfa, A. R. M., Roehrig, G. H., Schneider, J. L., & Nyachwaya, J. (2014). Collaborative discourse and the modeling of solution chemistry with magnetic 3D physical models–impact and characterization. *Chemistry Education Research and Practice*, *15*(4), 835-848

Wangdi, D., Precharattana, M., & Kanthang, P. (2020). A Guided Inquiry laboratory to enhance students' understanding of the Law of Mechanical Energy Conservation. *International Journal of Innovation in Science and Mathematics Education*, *28*(1).

Webb, N. M. (2009). The teacher's role in promoting collaborative dialogue in the classroom. *British Journal of Educational Psychology*, *79*(1), 1-28.

Westwood, P. (2008). *Direct Instruction (DI), what teachers need to know about teaching methods?* Victoria: ACER press.

Wihardjo, R. S. D., Nurani, Y., & Ramadhan, S. (2020). The Comparison between the Effectiveness of Guided Discovery Model and Inquiry Model for Early Childhood Education Students. *International Journal of Innovation, Creativity and Change*, *11*(3), 409-418.

Wilson, C.D, Taylor J.A, Kowalski S.M & Carlson J. (2009). The Relative Effects and Equity of Inquiry Based and Commonplace Science teaching on students'
www.simplypsychology.org/Zone-of-Proximal-Development.html

Yager, R. E., & Akcay, H. (2010). The advantages of an inquiry approach for science instruction in middle grades. *School Science and Mathematics*, *110*(1), 5-12.

Yusuf, M. O., & Afolabi, A. O. (2010). Effects of Computer Assisted Instruction (CAI) on Secondary School Students' Performance in Biology. *Turkish Online Journal of Educational Technology-TOJET*, *9*(1), 62-69

Zohrabi, M. (2013). Mixed method Researcher: instruments, validity, reliability and reporting findings. *Theory and Practice in Language Studies, 3*(2), 254-262.

Appendix A

Scientific process skills of lessions

Table 1 scientific process skills of lession one

Science Process Skill (SPS)	Total number of students (N)	Number of students observed	Percentage %
Observation (OB)	20	20	100
manipulation (MA)	20	15	75
experimentation (Ex)	20	15	75
communication (Cm)	20	9	45
drawing (DR)	20	8	40
Measuring	20	10	50

Table 4: Scientific process skills of lession two

Science Process Skill (SPS)	Total number of students (N)	Number of students	Percentage
Observation (OB)	28	25	89.28
manipulation (MA)	28	23	82.14
experimentation (Ex)	28	19	67.86
communication (Cm)	28	27	96.43
drawing (DR)	28	26	92.86
Measuring	28	15	53.57

Table 7: Science Process Skill (SPS)

Science Process Skill (SPS)	**Total number of students (N)**	**Number of students**	**Percentage**
Observation (OB)	35	35	100
manipulation (MA)	35	32	91.43
experimentation (Ex)	35	30	85.71
communication (Cm)	35	35	100
drawing (DR)	35	35	100
Measuring	35	30	85.71

Table 10: Scientific process skills of lession four

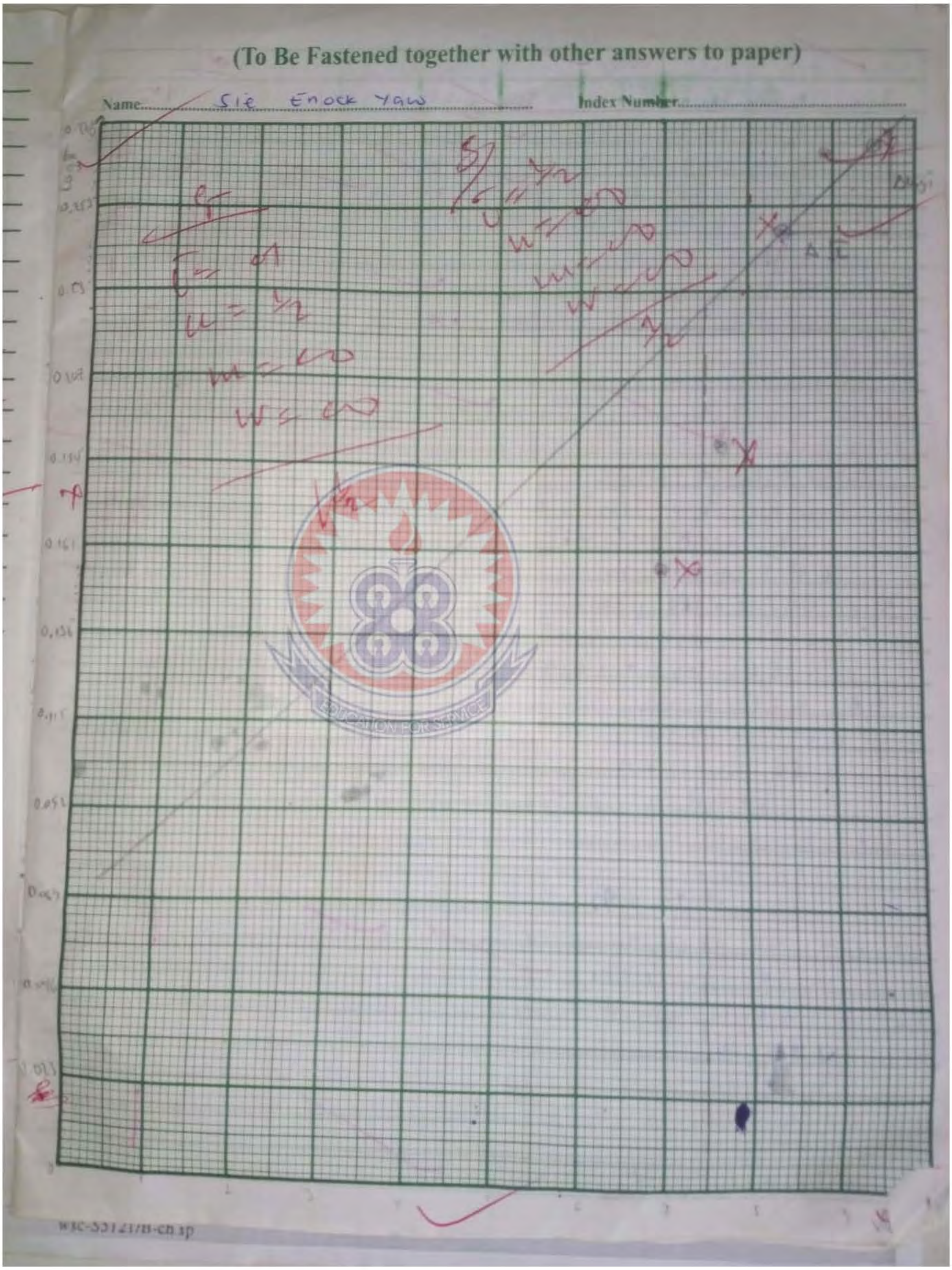
Science Process Skill (SPS)	Total number of students	Numberof students	Percentage
Observation (OB)	35	35	100
manipulation (MA)	35	34	97.14
experimentation (Ex)	35	30	85.71
communication (Cm)	35	35	100
drawing (DR)	35	35	100
Measuring	35	30	85.71

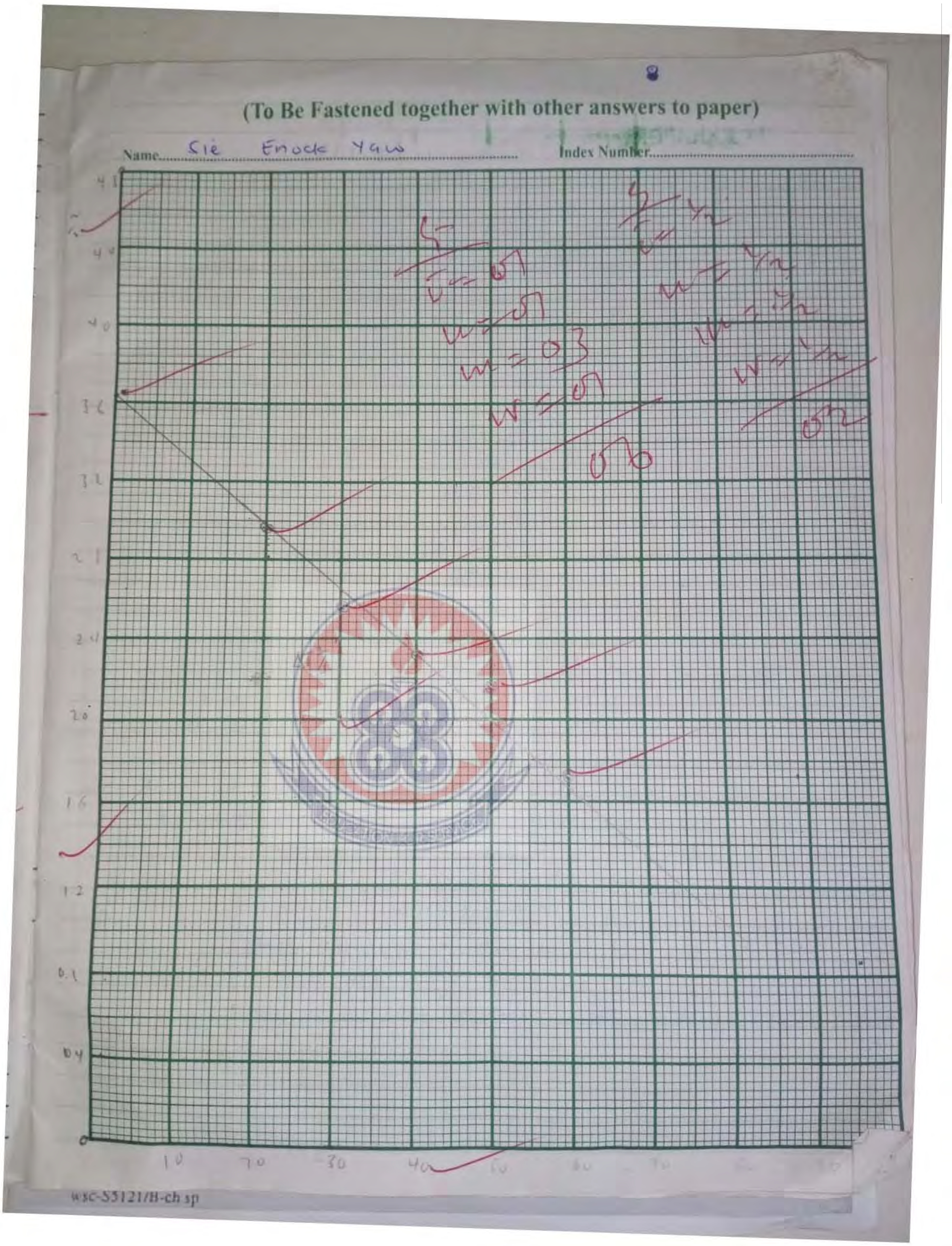
Table 13: Scientific process skills of lession five

Science Process Skill (SPS)	Total number of students	Number of students	Percentage
Observation (OB)	35	35	100
manipulation (MA)	35	34	97.14
experimentation (Ex)	35	33	94.29
communication (Cm)	35	35	100
drawing (DR)	35	35	100
Measuring	35	34	97.14

Appendix B

Questions for Student





(To Be Fastened together with other answers to paper)

Name Sie Enock Yaw Index Number

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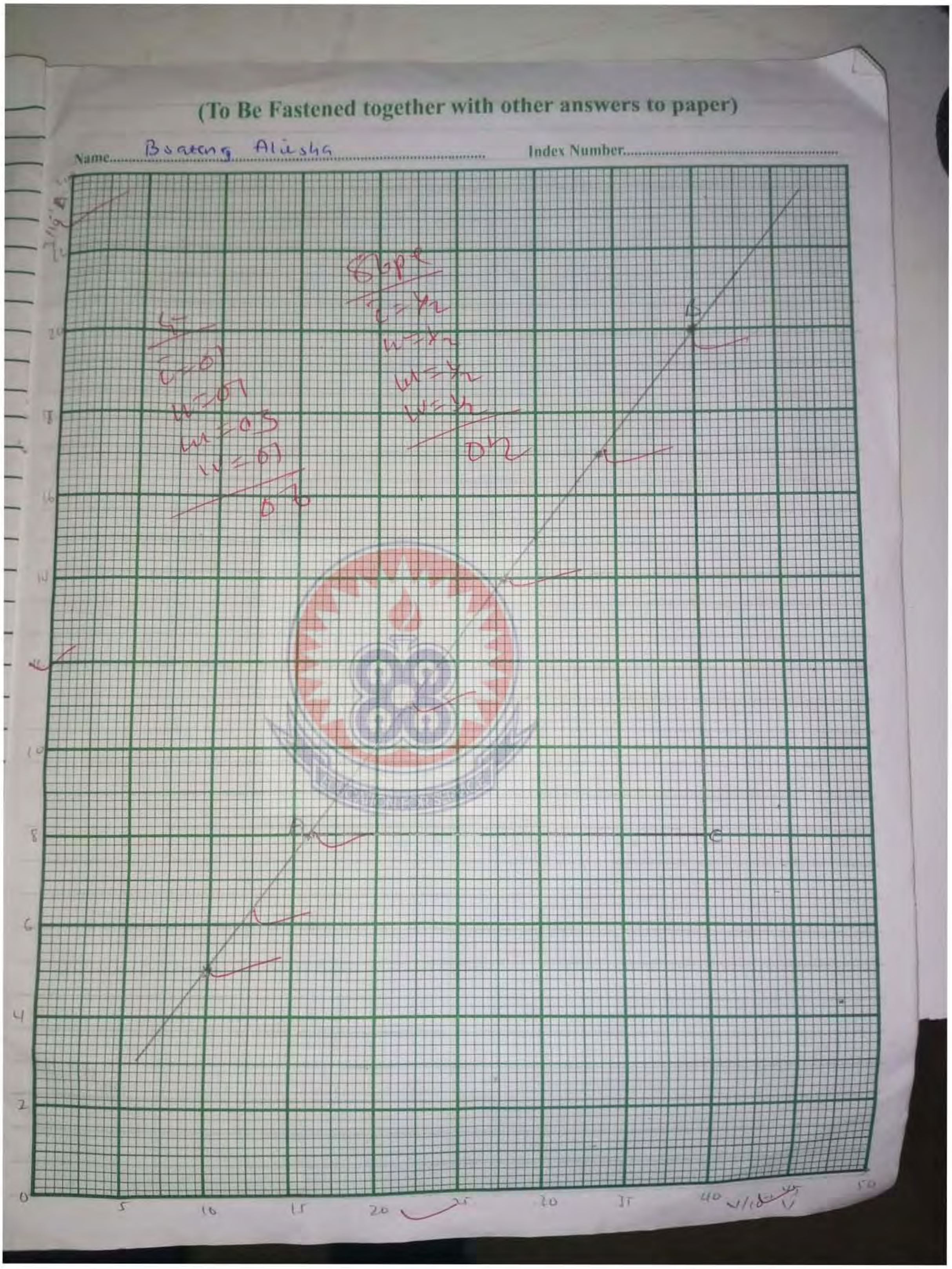
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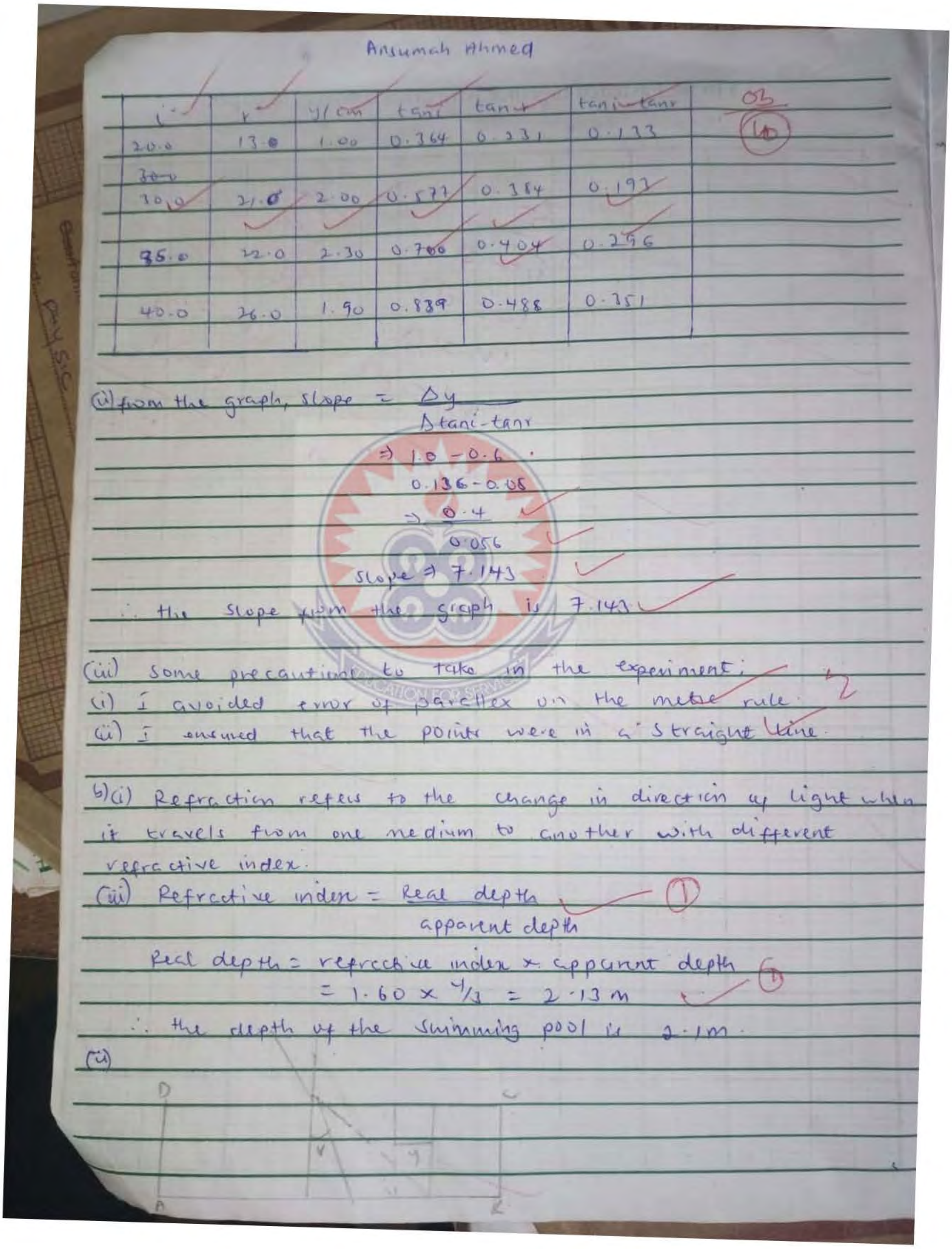
Appendix C

Marking scheme



Ansumah Ahmed

i	r	y/cm	tan i	tan r	tan i - tan r
20.0	13.0	1.00	0.364	0.231	0.133
30.0	21.0	2.00	0.577	0.384	0.193
35.0	22.0	2.30	0.700	0.404	0.296
40.0	26.0	1.90	0.839	0.488	0.351

08/10

(ii) from the graph, slope = Δy / Δtani-tanr

⇒ (1.0 − 0.6) / (0.136 − 0.08)

⇒ 0.4 / 0.056

slope ⇒ 7.143

∴ the slope from the graph is 7.143

(iii) Some precautions to take in the experiment;

(i) I avoided error of parallax on the metre rule.

(ii) I ensured that the points were in a straight line.

b)(i) Refraction refers to the change in direction of light when it travels from one medium to another with different refractive index.

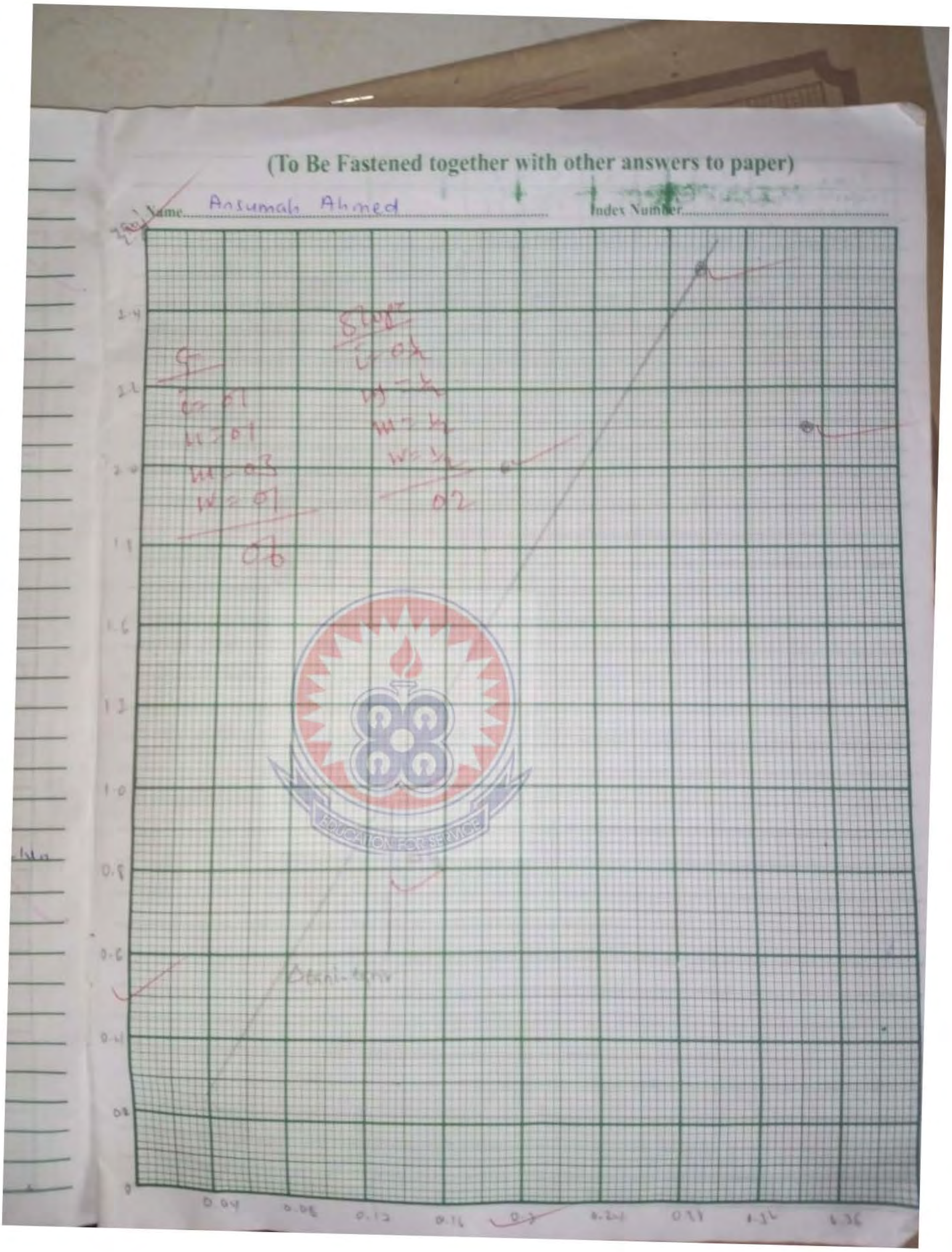
(ii) Refractive index = Real depth / apparent depth (1)

Real depth = refractive index × apparent depth (1)

= 1.60 × 4/3 = 2.13 m

∴ the depth of the swimming pool is 2.1m.

(c)


(To Be Fastened together with other answers to paper)
Name Ansumah Ahmed
Index Number

Sie Enock Yaw
Assignment

y/cm	t_1/s	t_2/s	t_{av}	$i = \frac{t_{av}}{20}$	i^2
20	34.50	34.40	34.45	1.723	2.969
30	32.00	32.20	32.10	1.605	2.576
40	30.00	31.10	30.55	1.528	2.335
50	29.29	29.42	29.36	1.468	2.155
60	26.32	26.07	26.20	1.310	1.716

03
~~96~~
4 – 01
5 – 02
P – 02
G = 01
I = 01
20

(x) slope, $\frac{\Delta i^2/s}{\Delta y/cm} = \frac{2.64 - 2.0}{30 - 50}$

$\Rightarrow \frac{0.64}{-20}$

slope, S $\Rightarrow -0.032 s^2 cm^{-1}$

(ii) intercept, 0.4 = 10

x = 9.14

$x = \frac{9.164(0.4)}{10} = 0.1456$

$x = \frac{9(0.4)}{10} = 3.64 s^2$

∴ the intercept is $3.64 s^2$

(xi) SR = C

$R = \frac{C}{S} = \frac{3.64 s^2}{0.032 s^2 cm^{-1}} = 113.75 cm$

(xii)(i) I avoided error of parallax on the metre rule.

(ii) I repeated the time twice for accuracy as shown in the table.

please check on your dp.

Sie Enock Yaw

Assignment

L/cm	t_1/s	t_2/s	t_{av}/s	$T=\frac{t_{av}}{20}$	$\sqrt{L}$	Log T
90.0	36.90	37.00	36.95	1.848	9.487	0.267
80.0	37.80	36.00	36.90	1.845	8.944	0.266
70.0	34.00	33.00	33.10	1.675	8.367	0.244
60.0	31.50	30.00	30.75	1.598	7.746	0.487
50.0	28.40	28.70	28.55	1.428	7.071	0.155

(a) (ix) slope, $s = \frac{\Delta \log T}{\Delta \sqrt{L}}$

$= \frac{0.274 - 0.244}{84 - 97}$

$\Rightarrow \frac{0.03}{-13}$

Slope, s $\Rightarrow -2.37 \times 10^{-3}\ s\,cm^{-1}$

(x) $g = \frac{4\pi^2}{s^2} = \frac{4(3.142)^2}{(2.37 \times 10^{-3})^2}$

$\Rightarrow \frac{39.5}{5.29 \times 10^{-6}\ s\,cm^{-1}}$

g $\Rightarrow$ ~~1260812.6.66~~ $7466918.72\ s^{-1}cm$

(xi) (i) I ensured a zero error when reading from the stopwatch.

(ii) I repeated the oscillation twice for each length for accuracy.

b (i) from the graph, the value of Log T when L = 75 cm is 0.2252

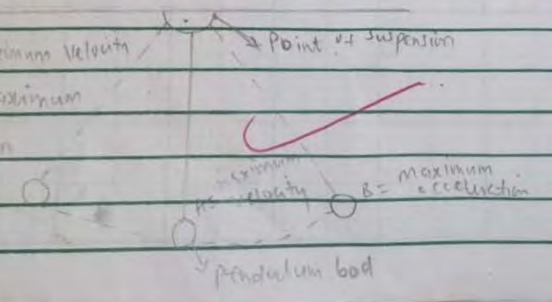
$\log T = 0.2252$

$T = 10^{0.2252} = 1.68\ s$

(ii)

Position A = maximum velocity

Position B = maximum acceleration



9

g - 1½

s - ½

p - ½

b (i) ½

u = 2

c = 1

16½

½

12

Boateng Aliesha

I/A	I - increasing V/V	I - decreasing V/V	Mean V/V
0.5	0.9	1.0	1.00
0.8	1.6	1.6	1.60
1.1	2.2	2.2	2.20
1.4	2.8	2.8	2.80
1.7	3.4	3.4	3.40
2.0	4.0	4.0	4.00

Plotted values

$V/10^{-1}V$	10	16	22	28	34	40
$I/10^{-1}A$	5	8	11	14	17	20

Seen

from the graph;

$s = \frac{CB}{AC} = \frac{(20-8)\times10^{-1}A}{(40-16)\times10^{-1}V} = \frac{12}{24}AV^{-1} = 0.500\,AV^{-1}$

(ii) Precautions in performing the experiment includes:

(i) I avoided short-circuiting

(ii) I ensured that all connections were tight and secured in order to allow continous flow of current.

(b)(i) Ohm's law states that the current passing through a metallic conductor is directly proportional to the potential difference between the ends provided the physical conditions such as temperature and pressure remains constant