IMPACTS OF PRIOR EXPOSURE TO LABORATORY APPARATUS ON ACQUISITION OF PROCESS-SKILLS, ACHIEVEMENT AND RETENTION AMONG CHEMISTRY SECONDARY STUDENTS, GIWA ZONE, NIGERIA

BY

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DECLARATION

1 hereby declare that this thesis titled "Impact of prior exposure to laboratory apparatus on acquisition of process skills, achievement and retention among chemistry secondary students in Giwa Educational Zone" has been written by me. It is a result of my own research work and it has not been presented in any previous application for a higher degree. All quotations and sources of information are fully acknowledged by means of references.

__________________________ ____ ________________________

Adeniyi Johnson, Babafemi **Date**

CERTIFICATION

This thesis titled "Impact of prior exposure to laboratory apparatus on acquisition of process skills, achievement and retention among chemistry secondary students, in Giwa Educational Zone". I Babafemi Adeniyi Johnson meets the requirement governing the award of Master Degree in Science Education (Chemistry) of Ahmadu Bello University, Zaria, and is approved for its contribution and literary presentation.

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This work is dedicated to Almighty God and my late father Samuel Idowu Babafemi. May his gentle soul rest in peace.

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ABBREVIATION

SSS -	-	Senior Secondary School
CAT -	-	Chemistry Achievement Test
SPSAT	-	Science Process Skills Acquisition Test
WACE	-	West African Examination Council
NECO-	-	National Examination Council
SD	-	Standard Deviation
FME	-	Federal Ministry of Education
EG	-	Experimental Group
CG	-	Control Group
NISP	-	Nigerian Integrated Science Project

Operational Definitions of Terms used in the study.

- **Laboratory** is a forum for science teachers and their students within a building to interact with apparatus in equipments under control condition when solving answers to problems in nature.
- **Science** is the systematic study of things around us. The totality of the knowledge obtained from such studies constitute scientific knowledge Wasagu (2011)
- **Chemistry** is the branch of pure sciences that deals with the composition and changes of matter. Eze Kannagha (2000).
- **Science Process Skills** are the abilities, potentials and technical know- how which can be developed through experience and used in carrying out mental operations and physical action (Brotherton & Preacel 1995, Nwosu 2004 Faruk 2006).
- **Retention** is the ability to remember and consequently recall things experienced or learnt by an individual at a later time.
- **Prior Exposure to Laboratory Apparatus** in any teaching and learning activity to observe and manipulate laboratory apparatus.
- **Prior Exposure** to laboratory apparatus on acquisition of science process skills that involve students observing and manipulating the laboratory apparatus.
- **Laboratory Apparatus"** is the term preference to "laboratory work" because location is not a salient feature in characterizing this kind of activity.

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ABSTRACT

The study examined the impact of prior exposure to Laboratory apparatus on acquisition of science process skills, academic achievement and retention in chemistry among secondary school students in Giwa Educational Zone. A total of 120 Senior Secondary two (SS II) chemistry students were in the study from a total population of 996. Non randomized pretest, post posttest, posttest experimental - control groups research design was used for the study. Chemistry Achievement Test (CAT) and Science Process Skills Achievement Test (SPSAT)were used as instruments with reliability values of 0.89 and 0.75 respectively. To determine whether students' prior exposed to laboratory apparatus on acquisition of science process skill, academic achievement and retention of different concepts in chemistry, t - test statistical tool at p^0.05 was used to analyse data collected for the study. Generally Prior exposure to laboratory apparatus on acquisition of process skills was found to be more effective in enhancing students academic achievement and retention on chemical concepts than those non prior exposed. The results also showed that both male and female students academic achievement are significantly high given the same condition of exposure to prior laboratory apparatus on acquisition and science- process skills. Therefore, recommendations were made among others that, science curriculum developers, Supervisory bodies of secondary schools, Science educators and teachers should incorporate prior exposure to laboratory apparatus on acquisition of science process skills approach into curricular of chemistry at secondary school level.

CHAPTER ONE

THE PROBLEM

1.1 Introduction

The world is living in the age of science and technology and our activities are being controlled and fashioned by science with the ultimate goal of transforming our society into a scientific and technological one so that its members can live conveniently in this modern age. Science has really revolutionalised many of the industrial and social activities of mankind. Abdullahi (2007) is of the view that science and technology are the foundation of national development and productivity and further added that to attain self-reliance and economic development, maximum premium must be placed on science and technology. Since Nigeria survival in the committee of nations would depend on her level of scientific and technological enterprise in line with National Policy on Education Objectives (FME, 2004), it also has indicated that the aim of science education is to, amongst others cultivate inquiry knowing and national mind for the conduct of a good life, democracy, and as well produce competent scientists for national development. In addition, it is to provide knowledge and understanding of the complexity of the physical world which can be achieved through the teaching of pure science such as chemistry.

As a result of the decline in the standard of education in Nigeria, many Nigeria science educators have become concerned about factors that have contributed to poor performance and retention of students in science, especially chemistry (Soyibo, 1996 & Okafor, 2002). The importance of science in general and chemistry in particular cannot be over-emphasized as the country cannot be developed without science and technological advancement.

Science as a branch of knowledge is the systematic study of things around us. The totality of the knowledge obtained from such studies constitutes scientific knowledge. Wasagu (2011) noted that, knowledge of science and technology is an important element of what it means to be an educated person in the 21st century and added that it is so because science and technology provides the only formidable base in which economic development of any nation can successfully stand. This could be achieved through effective teaching of pure science such as chemistry.

Chemistry is defined as a branch of pure science which deals with the composition, properties and uses of matter (Ababio, 1998). Okeke and Ezekannagha (2000) further defined chemistry as a branch of science that deals with the composition and changes of matter. Chemistry occupies a unique position as a result of its requirement as prerequisite to the study of courses like pharmacy, medicine, biology, agricultural science and so on Bajah (2000). Chemistry as a subject helps to develop the process skills of critical observation, experimentation, hypothesizing, manipulation of variables and equipment interpreting models and making references which were very important in the science process. These would not be actualized or achieved without chemists being exposed to laboratory apparatus.

Many research findings, (lvowi,2004, Ajewole,2005, Ajaja,2007)on the teaching of chemistry in Nigeria have revealed that chemistry as a science subject is poorly taught because of the use of inappropriate teaching method where students are not practically exposed to laboratory apparatus (Johnson, 2008), For instance Ali (2004) asserts that, "the present methods of teaching science do not encourage the development and sustenance of process skill among science students". According to Akuezuilo (2004) teaching is devoid of meaningful learning but oriented toward memorization and recall of facts. Okafor (2002) also observes that the slow pace at which science develop in Nigeria is linked to lack of qualified science teachers and poor teaching of science at all levels in the country. The recognition of the superiority of activity-based instruction methods over the other methods which allow manipulation of science has resulted in the recommendation of the process skills approach to science teaching as a method of instruction in science class (Feyzioghu, 2009). Many innovative science courses developed for Nigerian schools in the past 10-15 years including the Nigerian Integrated Science Projects (NISP) put emphasis on teaching and learning by inquiry and add that "the process skills approach is meant to foster inquiry and manipulative skills in students and discourage rote learning (Adeniyi,2004)..

Despite various research findings provided for the senior secondary school students, there has been a consistent decrease in the performance of students in SSCE science subjects. This may be attributed to the method of teaching and learning chemistry in the senior secondary school. However, literatures indicate that process skills development activities are not usually carried out during science class (Muhammed, 2002 & Usman, 2010). The process skills approach as observed in Mari (1994) and Sani (2007) is in line with Piagetian table as it offers a variety of activities and experience that involve use of concrete object. This hastens students' ability to conserve volume, mass and area of other events that predict changes. This process skills approach in chemistry may not be achieved without prior exposure of students to laboratory apparatus because the exposure of student to laboratory apparatus may provide hands on strategy necessary for development of character and process skills in science (Wasagu, 2011).

Although science may be regarded as a dynamic and objective process of seeking knowledge which involves scientist in the process of searching, investigating and seeking verification of natural things occurring in our environment. It can also be seen in terms of methods and processes as well as the products comprising facts, concepts, principles and laws that make up the body of science. From these views, if students learning chemistry are placed in a prior exposure to laboratory apparatus situation. This prior exposure to laboratory apparatus situation enriched with appropriate materials/equipments may enable them process scientific skills with a view to observe and manipulate laboratory apparatus approach.

Some researcher have even argued that the processes which make up this method otherwise referred to as science process skills are more important than the teaching of the products of science(Nwosu,2004). Science process skills are the abilities, potential and technical know- how which can be developed through experience and used in carrying out mental operations and physical actions (Brotherton & Preacel,1995; Nwosu,2004;Funk,2006). According to padilla(2009). They are transferable abilities appropriate to many science disciplines chemistry inclusive and reflective of the behavior of scientists.

Science process skills can be classified as either basic or integrated (Collette & Chiappetta,2004). Basic science process skills form the backbone of the more advanced laboratory apparatus approach skills and capacities. These include observing, communicating, measuring, inferring, classifying and predicting. It appears that basic skills provide the intellectual ground work in prior exposure to laboratory apparatus approach. Integrated science process skills combine two or more basic process skills and are therefore more advanced than basic process skills.

They are the immediate skills that could be used in prior exposure to laboratory apparatus approach. These include such skill as: identifying variables, formulating hypotheses, describing relationship between variables designing, investigations, experimenting, acquiring data, organizing data in tables and graphs, analyzing investigations and their data formulating models, defining variables operationally, understanding cause and effect relationships. Funk,(2006). Brotherton and Precce(1995).noted that scientists can only used integrated skills effectively once they have mastered the basic skills.

Science process skills are inseparable from the practice and study of chemistry and play a key role in both formal and informal learning of science content (Keil, Haney & Zoffel, 2009). They have the enduring quality that will contribute to students abilities to observes and manipulates even when the concept base of chemistry and approach changes. Hence, possession of these skills is basic to prior exposure to laboratory apparatus on scientific knowledge and the development of manipulative skills needed to learn chemistry concepts.

In recognition of this, the National Policy on Education (NERDC,2004) incorporated the acquisition of appropriate skills both mental and physical as equipment i.e laboratory apparatus for the individual to live in and contribute to the development of his society as one of the national education goals. However, it has been noted that "students at all levels show poorly developed skills of manipulating, handling and carrying out simple laboratory experiment.(Rebecca,2009) these lack of skills are part of a more general and widespread problem.

Therefore students should be prior exposed to laboratory apparatus during chemistry lessons in order to develop the appropriate process skills. But unfortunately, studies shows that the teaching of chemistry in Nigeria secondary schools falls short of certain expectations.(Ezeliora, 2008, Akinbobola & Afolabi ,2010). For instance, it has been observed that the present methods used in teaching science in secondary schools not only chemistry do not augur well for the acquisition of science process skills by students, Madu, (2004). Many researches have been carried out on the use of different teaching methods on students acquisition of process skills, academic achievement and retention in chemistry (Opara, 2011 & Mohammed, 2012).

However, none of these studies tried to examine the impact of prior exposure to laboratory apparatus on acquisition of process skills strategy.

The laboratory is a forum for science teachers and their students within a building to interact with apparatus or equipment under controlled condition when seeking answers to problems in nature. House (2009) is of the view that science most especially chemistry in its true form can hardly be taught or learnt without appropriate use of laboratory equipment/materials. House (2009) also contends that although a lot of reasoning and though process skills come into play, yet science cannot start and end without facts. In linking practical laboratory apparatus in chemistry with thinking, Florendo (2007) has this to contribute: The distinction between theory and practice is to some extent not real. We must argue that both are conductive to thinking practical, work should be a challenge to creative though and not just a process of looking, drawing and doing. It must be undertaken in order to solve problem. Florendo (2007) suggests that students should receive training in using laboratory facilities to approach the solution of problem through a proposed strategy and active involvement in the pursuit of the solution of an average Nigerian secondary school student shall encounter authority in different shade within the educational set up. Some of such "authorities" will includes the teachers, textbooks, visual aids among others.

The use of laboratory apparatus could not be effective without proper exposure to science process skills. The science process skills are essentially scientist's method of pursuit of knowledge. The use of tools, aids, laboratory apparatus help the scientists in the research, and such tools may ultimately lead to a break in Wilson's model and consequently the scientists will not obtain the desired results. In the same vein, the use of laboratory apparatus in secondary schools assists the students to be familiar with the science process skills and to achieve good results within the scope of his ability and competences. Johnson and mary (2006) observes that in schools where laboratory apparatus are inadequate, chemistry is usually taught theoretically. They further observed that this approach does not assist students to develop the science process skills approach to the study of chemistry. Moreso, lack of research work on prior exposure to laboratory apparatus is on scale and relatively new Johnson (2008). Therefore, there is need to carry out study in this area to see whether or not prior exposure of students to laboratory apparatus will enhance their science process skills acquisition and retention in chemistry at senior secondary school level.

In this research, prior exposure to laboratory apparatus means any teaching and learning activity which involves students in the opportunity to observe and manipulate laboratory apparatus. The term "laboratory apparatus" is used in preference to "laboratory work" because location is not a salient feature in characterizing this kind of activity. The observation and manipulation of objects could take place in a school laboratory, in the classroom setting when studying aspect of chemistry.

As earlier defined in this research work prior exposure to laboratory apparatus on acquisition of science process skills in any teaching and learning activity involves students observing and manipulating the laboratory apparatus. It is clear from this discussion and also widely recognized by science educators that much of the learning associated with practical activity takes place through the process of talking about the acquisition of process skills that have been made, and what they might mean, both other learners in the ciass and with the teacher. So a prior exposure to laboratory apparatus will be followed by a period of manipulation of the science process skills, and of how they might be interpreted and explained. Even if for practical reasons, the discussion takes place in a subsequent lesson. Therefore in this study prior exposure to laboratory apparatus on acquisition of process skills, academic achievement and retention among SSS chemistry students was investigated.

1.1.1 Theoretical Framework

Prior exposure to laboratory apparatus based on Gagnes(1965) theory of learning stated that any piece of knowledge can be acquired by students who posses certain pre-requisite pieces of knowledge which have their own pre-quisite inturn". According to this theory, prior knowledge determines what further learning may take place and Gagne (1965) believes that this type of learning structure is particularly important for subject like the nature of science. Therefore, believing that the meaningfulness of instructional material can be achieved through the shift from concrete operation to abstract operation when students are exposed to appropriate teaching instructional materials piaget (1968). Gagne(1968) system for categorizing learning provided a very useful frame work for instruction.

Ausubel's (1965) prior knowledge and learning of science has advanced as cognitive theory of learning that is specifically intended to deal almost exclusively with what he calls meaningful verbal learning. According to Ausubel's (1965) "A concept acquires real meaning when it is equivalent to an idea that is already present in the mind". This means that meaning depends on the existence of some equivalent representation in the mind.

In other words, in order for an external stimulus concept to have meaning there must be something in the learners consciousness to which it can be equiated. This "something" is labeled cognitive structure. So also the acquisition process skills on achievement and retention in chemistry will be meaningful for an individual student when he/she had been prior exposed to laboratory apparatus.

Ausubel s theory of learning (1965) distinguishes between rote and meaningful learning of science on the one hand and how prior knowledge affects the learning process of science on the other hand. According to Ausubel s(1965) "meaningful learning occurs when there is interaction between the students appropriate elements in the knowledge that already exists and new materials to be learnt".

However, where such interaction does not take place, rote learning occurs. Those parts of the learners cognitive structure (organisation of knowledge) which can provide for the interaction necessary for meaningful learning called "sub-summers".

Prior exposure to laboratory apparatus is necessary for developing students understanding of chemistry concepts and explanations. Students need to have experiences on the activity in the world and in the light of a theory or model, feeling the outcomes. Only in this way can they come to an understanding of the theoretical presentations that we impose on the real world in order to help explain it and predict the behavior. This will improve students achievement and retention ability in the subject and thereby reducing the rate of failures.

1.2 Statement of the Problem

Chemistry over the years has developed through a series of discoveries such as those of Plato (428-347BC), Democratic (470-380BC), Dalton (1908), etc Chemists are supposed to use their senses to observe the activities that happen around them and further apply the science process skills such as observation, hypothesis, classification measurement, experimentation, inference and so on to solve day to day problem. These process skills require the use of laboratory apparatus which is not so in our senior secondary school as observed by (Mari 1994 &Sani 2007).

Reports however shows consistent poor academic achievements in chemistry practical at secondary school level. (Danladi 2003, Ivowi 2004, Ajaja

2007) attributed this to students' poor manipulative skills, insufficient instructional materials, poor method of teaching employed, mathematical aspect and abstract nature of the chemical concepts.

An instructional strategy that could allow the students to increase their creative thinking and self confidence in handling and solving problem in laboratory apparatus creativity may likely enhance their academic achievements.

Danjuma 2005 observed that laboratory activity based instructional strategy used of laboratory apparatus as discovering method, demonstration and problem solving instructional strategy could enhance academic achievements, self confidence and creative thinking in learners.

This study seek to determine if prior experiment to laboratory apparatus could impact on students acquisition of science process skill or not, it will also determine, if prior exposure to laboratory apparatus could impact creativity among learners or not.

Researchers such as Danjuma 2005 have also linked creativity to science process skills and achievements in science.

This is expected as skills like manipulative skills, self confidence evaluation, communication and logical reasoning ability are related to creative skills. Thus it seems, prior exposure to laboratory apparatus instructional strategy could impact self confidence, creativity and sequent achievement in chemistry.

Results of several researches conducted over the year have indicated that of all the various factors responsible for poor achievement and retention of students in chemistry, poor method of teaching predominate (Danladi 2003; IVowi; 2004; Ajewole, 2005; Ajaja, 2007). However, Ajewole (2005) and Ajaja,(2007) suggests the need to adopt a new strategy involving students acquiring science process skills as well as enhancing their academic achievement and retention that deviate in the style of teaching from the traditional approach to active learning technique. Thus, the problem of this study was to try the prior exposure of students to laboratory apparatus on their science process skills acquisition, achievement and retention with a view of determining its impact on the three variables.

1.3 Objectives of the Study

The study is geared towards achieving the following objectives which are to:

i. determine the impact of prior laboratory apparatus exposure on the science process skills acquisition among senior secondary school students in chemistry,

ii. investigate the impact of prior laboratory apparatus exposure on academic achievement among secondary school chemistry students.

iii. determine the effectiveness of prior laboratory apparatus exposure on the retention ability of secondary school chemistry students.

iv. determine whether or not prior exposure of laboratory apparatus on science process skill is gender related or not.

1.4 Research Questions

The following research questions are formulated to guide the study:

i. What is the difference in the mean academic achievement of secondary school chemistry students prior exposure to laboratory apparatus compared to those not so exposed .?

ii. How would the academic achievement of students prior exposed to laboratory apparatus on acquisition of process skills of chemistry differ from those not so exposed.?

iii. What is the difference in the retention ability of chemistry students prior exposure to laboratory apparatus on acquisition of process skills compared to those not so exposed.?

iv. What is the difference in the academic achievement of boys and girls when exposed to prior exposure of laboratory apparatus on acquisition of process skills compared to those not exposed.?

1.5 Null Hypotheses

In line with stated research questions, the following hypotheses are formulated for testing at $p < 0.05$.

Ho_1 There is no significant difference between the mean academic achievement of chemistry students prior exposed to laboratory apparatus on acquisition of process skills and their counterpart not so exposed.

Ho_2 There is no significant difference between the acquisition of process skills of chemistry students prior exposed to laboratory apparatus on their academic achievement and their counterpart not so exposed.

Ho_3 There is no significant difference between the retention ability of chemistry students prior exposed to laboratory apparatus on acquisition of process skills and those not so exposed.

HO_4 There is no significant difference between the academic achievement of boys and girls prior exposed to laboratory apparatus on acquisition of science process skills and their counterpart not so exposed.

1.6 Significance of the Study

The idea behind an academic research of this nature is to add to the existing knowledge. This is so because problems are identified, solutions provided, hence, improvement is often expected. In science, a process approach, the ability to read is not essential as it is in many traditional curricula. Success does not depend on reading skills only, but also on the ability to manipulate laboratory apparatus on science process skills. The finding of this study will hopefully be beneficial to the upliftment of science education as follows:

i. Provide useful information for teachers and will serve as a guide in handling different types of practical classes and students based practical activities. By doing so, the teacher will be able to display the desirable instructional behaviour that will lead students to higher achievement and retention.

ii. Curriculum and educational planners will find the results of this study very valuable for curriculum review in science by emphasis on the use of prior laboratory apparatus in chemistry teaching at senior secondary school level.

iii. Educational planners will hopefully find the result of this study as a means of launching strategy that could be emphasized on teaching and learning of science processes skills. With emphasis on laboratory activities.

Educators have also been trying to find a good means of teaching sciences through the use of science process skills. This research work therefore provides a model lesson plan suitable for use in teaching certain concepts in chemistry in our senior secondary schools. Furthermore, it is hoped that the result of this study will make an enormous contribution to the existing literature in the area of science teaching method and to fellow researchers.

1.7 Scope of the Study

The study is delimited to the senior secondary schools class in Giwa Educational Zone. SS II students were chosen for the study due to the fact that SS I are just newly introduced into chemistry, while in SS III the students would have been planning to write their SSCE. The scopes of science process skills to be selected for this study were the Basic Science Skills. These are: observation, hypothesis, classification, measurement, manipulation experimentation and inference. Because the concept selected for teaching is in the SS2 syllabus, which is Volumetric analysis, quantitative analysis, method of separation techniques that involves the use of laboratory apparatus and these choice are some of the difficult areas students failed during chemistry practical as reported by WAEC chief examiner (WAEC 2008,2009,2010).

1.8 Basic Assumptions

The study was based on the following assumptions:

i. The schools understudy are using the same SSCE syllabus as recommended by WAEC/NECO

ii. The schools understudy have adequate laboratory facilities for the teaching of chemistry.
iii. The study sample had been adequately exposed to laboratory apparatus in teaching and learning of chemistry.
iv. The students in the school are exposed to similar educational programme obtained from state education school syllabus.
v. The study subjects had been expose to teachings that promote the use of prior exposure to laboratory apparatus on acquisition of science process skills.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.01 Introduction

In this chapter, an attempt was made by examining related literatures on this study. Specifically, the areas reviewed are presented in the following sub-headings:

- Meaning and Nature of Science.
- Chemistry Teaching at Secondary School Level, the Teaching and Learning of Chemistry
- Learning in the Chemistry Laboratory
- Concept of Volumetric Analysis
- Prior Exposure to Laboratory Apparatus
- Laboratory Apparatus and Acquisition of Process Skills in Science
- Studies on Students Academics Achievement on Laboratory Apparatus manipulation in science
- Students Retention ability in Chemistry
- Gender - related differences in the learning of Science
- Gender - Related Differences and Exposure to Laboratory Apparatus on Acquisition of Process Science Skills
- Overview of Similar Studies
- Implication of the Literature Reviewed on the Present Study.

2.02 The Meaning and Nature of Science

View about the structure and meaning of science vary as the number of those who define it (Musa, 2000) some view it as the method, while others perceived it in relation to outcomes of science investigation, its process and products. Abdullah! (2007) review the configurationally nature of science as Comprising of concepts, laws and theories metamorphosing into a wonderfully structured body of knowledge called science. Reasoning along this line of thought, Mari (1994) identified additional aspects of the nature of science to include;

- A method or process of acquiring knowledge which involves the use of process of skills like measuring hypothesizing, classifying, observing etc
- part of main culture whose products and activities has social relevance to mankind.
- Human activities carried out by scientists, which require certain attitudes and beliefs as objectivity, curiosity, skepticism, open mindedness etc.
- A social institution and an important agent of social change. The political, economic and technological development of a community is however believed to be transformed through the acquisition and proper utilization of scientific knowledge.

According to Akpan (2012), scientific knowledge is purely an expansion of common sense and the growth of it can meaningfully be explored by systematically studying the growth of accumulated scientific fact. It is highly cumulative enterprise whose success depends on the steady extension or widening of the scope and precision of each successive scientific facts which are unchanging truths found some where in nature and upon which all scientific knowledge is based.

In spite of the fact that scientists believe that science knowledge is activity- oriented, it is tentative and most of the time uncertain, it is also continuously being influenced by numerous social and cultural factors (Richardson & Boyles in Akpan 2012), View scientific knowledge as uncertain and tentative way of imagining or re- constructing certain aspects of reality based on accumulation of facts, laws and theories. Ogunleye (2011) opined that science should be recognized and taught as a major human activity which explores the realm of human experience, map it methodically but also imaginatively, and by disciplined speculation, create a coherent system of knowledge. Furthermore, Ogunleye, identified two philosophical position which are scientific and rationalism.

Empiricism recognizes experience as the only source of knowledge with emphasis placed on sensory experience although some allowance is made too for knowledge rived from intellectual reflection regarding relations among a number of experiences. Hume in Mari (1994) identified impression and ideals as the basic components of perception of the mind. He recognized impression to be the direct sensation received by the sense as the basic all knowledge. The images of these senses which remain after an impression has occurred, Hume regards as simple ideals.

The sensory impression of an object according to Ogunleye (2011) is decomposable into a set of sensory qualities all becomes associated in the mind because they occur closely together in time or in space as interaction with objects goes on. The sensory qualities of objects may include:

- Sensationalism: - The hypothesis that all knowledge is derived from/through sensory experience
- Reductionalism: - The thesis that all complex ideals are build up out of basic stock of simple ideals and that they are in turn reducible to these basic elements.
- Associationism: - The thesis that ideals (or mental elements) are connected through the action of association by continuity in experience
- Mechanism: - The belief that the mind is like a machine built out of simple elements with no mysterious components simple additive rules serving to characterize the properties of complex associative configuration by sole use of properties of the underlying simple ideals.

Science is like a game, which changes with time. So what may be scientific today may become unscientific tomorrow (Akpan 2012). Reflecting on the consensus view of science, Akpan explains that scientific knowledge is achieved through consensus among the practicing scientists of the time. This means that before my new scientific fact becomes acceptable to the scientific community it has to negotiate a number of huddles in order to enhance public verifiability according to the consensus of trained scientific.

Moreover, scientific activities according to Abdullah! (2007) differ according to the kind nature of problem confronting the scientist concerned. However, the following steps identified by Abdullah! (2007) are believed to constitute scientific methods:

- The recognition of problem
- Collection of relevant information
- The formulation of working hypothesis
- The marking of deduction from the hypothesis
- Testing by actual experimentation of deduction
- Depending on the outcome or result of the experiment the working hypothesis is maintained, modified or rejected. Scientific investigation must involve all of the above operations although the order of operation may vary depending on the nature of the problem under investigation (Abdullahi 2007) and (Eniayeju 2012). In this study therefore an investigation was carried out on the effect of prior exposure to laboratory apparatus on chemistry students and their acquisition on process skills.

2.03 Chemistry Teaching at Secondary School Level and The Teaching and Learning of Chemistry

Chemistry is one of the major branches of science. There are various applications of Chemistry in home or industry. There is an increasing impact of growing knowledge in the subject of chemistry on our social and economic life. A poor chemistry foundation at the secondary school will jeopardize any future effort to enhance achievement in the subject. The study of chemistry at the secondary school level helps students in developing basic skills, knowledge and competence required for problem solving in their environment. According to Ohodo (2005) chemistry contributes generally to the attainment of the aims of education and specifically helps individuals to develop effective process skills, critical thinking and competences required for dealing with observation, classification, measurement, counting numbers, recording, communication, prediction, hypothesis, inference, experimentation, interpretation of data, research, controlling variable and generalization etc. At the secondary level, the foundation of chemistry education is laid as they are taught the underlying principles.

The poor achievement of learners in chemistry has been variously explained. According to Usman and Memeh (2007), the factors that negatively affect chemistry achievement include students' background problems; students' lack of interest and/or negative attitude towards chemistry; teacher related factors like poor teacher preparation; inadequate qualified chemistry teachers, inadequate instructional materials and application of poor teaching methods. In Nigeria efforts are being made by researchers, government and nongovernmental organization to improve cognitive, affective and psychomotor outcomes in chemistry. For instance, a good number of research efforts have been made to diagnose the problems associated with the teaching and learning of chemistry in order to proffer solution that lead to better achievement. Recommendations have been made regarding the teaching methods, instructional materials, home and school related environmental factors that could enhance achievement in chemistry. However, as evidence available indicates, achievement in chemistry at the secondary school remains low and unimpressive. The federal government of Nigeria is not left out in this effort to revamp interest in the study of science, especially chemistry and improve achievement in the subject.

Chemistry teachers mainly adopt instructional strategies that are mainly teacher directed and do not encourage deeper students involvement and self-regulation (Simon & Zimmerman, 1990) self-regulated learners, who possess relevant skills which enhance their ability to construct knowledge, assume responsibility for their own learning and realizes that learning is a personal experience that requires active and dedicated participation (Peters, 2000, and Kerr, 2003). This perception of the role of the learners in the learning processes is changing the views of educational researchers on the role of the teacher in the learning process. Instead of viewing teaching as teacher exposition followed by students practice, effective teaching may be achieved by integrating a prior exposure to laboratory apparatus On acquisition of process skills in the process. The prior exposure to laboratory apparatus approach to learning locates understanding within the learners, not with the teachers. It is the learners who must learn and therefore must take the responsibility for learning. According to Kerr, (2003), learning is based on an appropriate self-reflection which leads to meaningful knowledge construction.

Trends in research in some western countries tend to suggest that prior exposure to laboratory apparatus strategy enhances learners' self-regulated behaviour and academic achievement. Prior exposure to laboratory apparatus is a self-monitoring approach in which learners get involved in the assessment of their own progress and deficiencies in the process of learning (Rebecca, 2001). As learners monitor their own learning, they learn to check their own responses and become conscious of errors or answer that do not make sense. Schunk (1990) opined that prior exposure laboratory apparatus is simply judging the quality of one's work, it is a process of assessing the quality of work done based on evidence and explicit criteria. This suggests that prior exposure to laboratory apparatus is goal oriented. To achieve the desired goal will require the active involvement of the learners in the process and the development of skills.

Research findings have suggested that learners who possess relevant skills in prior exposure to laboratory apparatus are aware of these skills are more strategic in pursuing learning and achieve better in their academic endeavour (Kerr, 2003: Rebecca 2001). When learners are exposed to the acquisition of process skills their self-assessment progresses, they achieve more. As Bandura (1997) and Schunk (1996) observed that a positive self-assessment will encourage students to set higher goals and commit more personal resources to learning the task. However,a negative self-assessment arises when learners embrace goals that conflicts with learning or select goals that are unrealistic or adopt strategies that are ineffective or exert low effort. Rebecca (2001) observed that when skills in prior laboratory apparatus are acquired, they become potentially, powerfully, stimulants to higher achievement.

Literature reviews indicate that most of the studies that investigated the efficacy of prior exposure to laboratory apparatus are foreign to Nigerian culture and most of them were in English comprehension, prose and reading. This created the need to design a study to determine the extent instruction in prior exposure to laboratory apparatus strategy would enhance the chemistry achievement of senior secondary school students.

Prior exposure to laboratory apparatus has been associated with individual learners' perceived self-efficacy. Learners who are exposed to laboratory apparatus skills have been suggested to persist more on difficult tasks, be more confident about their ability and take greater responsibility for their learning tasks (Daley, 2002; Kerr 2003). Self-efficacy has been described as a set of belief an individual has about his/her abilities or capabilities in specific performance domain (Bandura, 1994). Individuals' self-efficacy belief influences choice of task, the amount of effort expanded and level of persistence in the selected task. Thus learners who possess a repertoire of earning skills are more likely to be efficient learners with high self-efficacy. Successful learners seem to control and direct their thinking process, ask themselves questions and try to organize their thought. They have learnt how to go about their learning and possess relevant cognitive strategies they can apply as necessary. On the contrary, low self-efficacy belief is associated with conditions of learned helplessness, a severely debilitating belief that one has no control over ones learning (Sariba & Hale 2009).

In spite of efforts by educational researchers to improve school achievement especially Chemistry, less attention has been paid to the effective component of the learner such as their perceived self-efficacy. This study therefore determined the extent the prior exposure of laboratory apparatus on science process skills could affect the chemistry learning of senior secondary school students in Giwa Educational Zone.

Gunstone and woolnough (2011) carried out a survey of science teaching in ten existing grammar schools and came out with the following.

a. That laboratory apparatus provision was inadequate in two schools; seven schools had accepted minimum while one school was found satisfactory or excellent.

b. That the situation of laboratory apparatus provision was less satisfactory in new schools and established schools just starting science (chemistry).

c. That no school had sufficient weighing balance, test tubes, pipettes, etc, for individual work (for 40 or more students) he noticed that only one school had sufficient for work in students (15 - 30 students). Another school had sufficient for small classes of 10 - 14 students.

An observation similar to Gunstone (2001) was also made by Ogunleye (2010) in his study of laboratory in secondary schools. Okeke (2012) and Osisioma (2012) in their investigation studies into the problem of teaching chemistry also identified inadequate laboratory apparatus as one of the major problems. A survey conducted in the united states of America by the National science formulation (2000 / 2001) to find out the problem area of science instruction as perceived by science teacher mostly in chemistry showed that science instruction has problems in three areas namely:

A) Inadequate laboratory apparatus

B) Insufficient fund for supply and purchase of equipment

C) Lack of materials for individualizing instruction

Is it the laboratory with its equipment that is all-important itself or the changes in behaviors that may occur in the learners after some learning experience in the areas of scientific processes?. Also, what role do the science equipment / facilities i.e. laboratory apparatus play in the development of the learners?

Bogner (2012) constructed laboratory method of learning science with lecture method and demonstration method and came out with the following results.

a) That the laboratory apparatus method is superior and statistically significant in area dealing with scientific attitudes and certain abilities in problem solving for general education in chemistry.

b) That laboratory apparatus method appears to be superior for providing knowledge and method of attack.

c) That for laboratory manipulation and skills and understanding of apparatus, the laboratory, apparatus method is superior.

Although no comprehensive studies have yet been made of the manual skills involved in science laboratory apparatus work in schools, kerr (2003) was of the view that manual and coordinating skills are developed in students of both serves The Science Association of Great Britain is of the view that each student should do the utmost amount of practical work which is consistent with his own experimental skill. They argued that unless a student has handled apparatus, has appreciated the utmost unlimited possibilities of errors, the necessary repetition and checking needed to detect errors, he has not gained an insight into modern science methods.

In this study, one intends to agree very much with the opinions expressed by the science masters Association which says that , if the Nigeria student is ever to have the opportunity of becoming a scientist and an inventory, it is worth noting that laboratory apparatus and facilities are central to this accomplishment. In a similar view to Great Britain science masters Association, House (2009) is of the view that science in its true form can hardly be taught or learnt without appropriate materials. They contented that although a lot of reasoning and though process skills come into play, yet science cannot start and end without facts. In linking practical laboratory work in chemistry with

Thinking Green (1995) has this to contribute:

> "The distinction between theory and practices to some extents artificial. We must argue that both are conductive it thinking practical work should be a challenge to creative though and not just a process of looking, drawing and doing. It must be under taken in order to solve problem".

Anderson (2011) suggested that student should receive training in using laboratory apparatus to approach the solution of problem. Though a process skill strategy and active involvement in the pursuit of the solution of an average Nigerian students shall encounter authority in different shade within the educational set up, some of such "authority" will include the teachers, textbooks, visual acids among others.

In chemistry, as in other areas of science such "authorities" may be presented as concepts principles, hypotheses, theories, definitions and laws in order that the Nigerian students may benefit fully from science education, he needs to learn through experiencing that science as an enterprise is authoritarian. The real authority of science resides in the logic of man and the data from nature (House 2009). The sceptic nature of the scientist can in part be acquired by the Nigerian students by working with laboratory apparatus in the laboratory, In order to help Nigerian secondary school students improve on their abilities and skills in the attainment of science skills.

Bogner (2012) suggested adequate stimulation from outside and appropriate interaction opportunity with the environment. This is of value in sciences. Since most of the materials for its study are abundant in nature in the earth crust. The argument in favor of adequate laboratory apparatus on science process skill acquisition in the learning and teaching of chemistry are convincing in themselves. To think of learning chemistry without these apparatus is synonymous with thinking of a motor machine working without his tools. How else shall it function? Therefore,, this study intends to find out the influence of prior exposure laboratory apparatus on science processes skills acquisition, performance and retention in chemistry among secondary school students.

2.04 Learning in The Chemistry Laboratory

Laboratory activities and other forms of practical activities are gaining ground/spreading wide, but not universal acceptance as one of the most important and essential elements in the teaching and learning of chemistry. For the purpose of this research, the researcher concentrate on prior exposure to laboratory apparatus and it activities to see if its principle could be apply equally to the range of practical activities encountered in the sciences.

Here, the researcher provides a brief overview of the Literature on Laboratory apparatus activities as a means of helping in answering the following questions:

- What are the effectiveness of teaching chemistry into the laboratories using prior exposure to laboratory apparatus.
- What strategies are available for teaching in chemistry laboratories and how they can be prior expose to laboratory apparatus.
- How can we assess the outcomes of prior exposure to laboratory apparatus.

Chemistry is a practical subject and so we must do laboratory activities/ work. One might say that the effectiveness of prior exposure to laboratory apparatus is to teach hand skills and to illustrate theory. But is this the end of the story?

If we are going to look at the variety of strategies available for laboratory activities, one shall have to be clearer about the effectiveness of prior exposure to laboratory apparatus to enable us decide which of those strategies land themselves best to the academic achievement and retention ability in our students. Such idea have been under discussion for decades especially in places like Britain, where a great deal of time and money have been spent or using practical activities in teaching of science. Johnstone (2009).

As a result of this, a list of ten effectiveness for practical activities and laboratory apparatus were compiled. These are:

- To encourage accurate observation and careful recording.
- To promote simple, commonsense, scientific methods of thought.
- To develop manipulative skills
- To give training in problem solving
- To fit the requirements of practical exam requirement
- To elucidate theoretical work so as to aid comprehension
- To verify facts and principles already taught
- To be an integral part of the process of finding facts by investigating and arriving at principles
- To arrest and maintain interest in the subject chemistry
- To make phenomena more through actual feeling / experiences

Prior exposure to laboratory apparatus should aim to encourage students to gain:

- Manipulative skills
- Observational skills
- the ability to interprete experimental data.

Johnstone (2009) expresses that, the effectiveness of prior exposure to laboratory apparatus as mentioned above could also includes:

- Interest in the subject chemistry
- Enjoyment of the subject chemistry
- A feeling of reality for the phenomena talked about in theory.

2.4.1 Manipulative Skills

It is true that, laboratories are the only place where one could be exposed to learn hand skills, but many of the skills depend upon the particular piece of laboratory apparatus/equipment available. Not all infrared machines are the same, each having its own peculiar 'flicks of the wrist' to make it operate well. Although the students has to learn the manual skills with the apparatus available, What is important is to know how to handle and interpret the spectra from any machine and this can be done without a laboratory. Manipulative skills have to be encountered often, if the students are to be well prior exposed to laboratory apparatus.

A large gap between prior exposure and learning to operate a particular balance and using it again requires almost total relearning. Problems with facility in manipulative skills can seriously get in the way of other desirable skills if not prior exposed. A student struggling to operate a piece of equipment may fail to make important observations and gather prior data because of not prior exposed. A classical information overload can occur under these circumstances. It is essential so to establish the manipulative skills that this can go on auto pilot and free the student's attention for other things such as observation and accurate recording.

2.4.2 Observational Skills

Observation is a longitude process and it becomes scientific when it has purpose and theoretical perspective. Johnstone (2009) made it clear that, there is a difference between "seeing' and "observing' when he stated that learners 'see' many things' but they do not always "observe' them. Do learners notice every observation that could be made? Johnstone and AI-Shuaili (2009) reported that students failed to notice or record one in every three observations. They reported that observability is a function of both the nature and intensity of a stimulus and the observer's perceptual characteristics. The observational stimulus must reach a certain level below which observation will not be made i.e observation threshold. They printed out that as the intensity or magnitude of an observational stimulus is reduced, it becomes more difficult to detect. Moreover, when there are multi-stimulus, the "detectability' of one stimulus can be seriously affected by the presence of another. The dominant stimulus obscuring or masking completely, the less dominant ones.

This psychological factor affects learner's throughout their lives, it is not enough to tell students to observes, they have to be pre-exposed. However, some of the greatest observations in science have been made by chance, such as the discovery of polyethylene, but the observer's had to have prepared minds to see the possibilities behind their observations.

In practice by using prior-exposure to laboratory apparatus which is interactive techniques in nature. Johnstone and Al-Shuraili (2009) showed that visual observational changes, which might go unnoticed in a normal laboratory activities could be made to appear well above the detection threshold. Therefore whilst prior exposure to laboratory apparatus, the instructor can highlight the kind of strings learners should be looking for in order to fulfil the task's aim of focusing on laboratory apparatus and suppressing 'Noise'.

According to Hodson and Johnstone (2006) observation would appear to be more than merely seeing and seeing would appear to be more than simply receiving sense data. Raw sense data can be 'seen' almost unconsciously without having any significance attached to them.

However, when this seeing is registered and interpreted in the light of prior knowledge and expectation, it becomes an observation. This emphasises the importance of having a prepare mind before setting out in a laboratory activities or chemical concept in chemistry and clearly calls for prior exposure to laboratory apparatus.

Hodson and Johnstone (2006) remarked, "knowing what is observe, knowing how to observe it, observing it and describing the observation are all theory dependent and therefore fallible and biased.

In laboratory activities, a further complication to observation is that prior exposure to laboratory apparatus often masks a phenomenon that people's memories of their school science often relate more to the dramatic equipment than to its significance for scientific ideas. Because of this, it is important to take some time to expose a piece of apparatus, with the intention of making it sufficiently familiar so that the class can forget it and focus attention on the phenomenon.

2.05 Concept of Volumetric Analysis?

Quantitative Chemistry is a branch of science that studies and differentiates matter in a chemical and molecular level using laboratory tests and equipments to show visible results.

Volumetric analysis is one of the laboratory test used in quantitative chemistry to show the relationship of a molecule's composition and the way they to. This also called volumetric titration because all experiments under this method of analysis are completed by titration reaction

2.5.1 Volumetric Analysis

Volumetric analysis is a method of determining chemical differences and principle of redox (reduction-oxidation) reactions between molecules. Chemicals under this topic and classified based on the results obtained from titration

2.5.2 Titration

The process of creating a balance chemical equation in is called titration. it typically uses a volumetric called volumetric titration

There are three types of volumetric titration which are classified based on the rate of their reaction.

- Direct titration method (DTM): is a one step titration process
- Indirect titration method (ITM): is a two step titration process
- Back titration method (BTM): Uses a three step process.

2.5.3 Principle

The principle involved in all titration methods is to balance a chemical reaction such as achieving acid and base equilibrium. The most important key is to attain the derived and point regardless of the steps involved in the process. Therefore, it does not matter if it is processed using direct, indirect or back titration method because they will still arrive at the same equivalent end point.

2.5.4 The Process

Titration starts by preparing two solutions the analyte and titrant. Add an indicator to your analyte and then slowly add your titrant solution in a drop wise manner until the analyte changes it color

2.5.5 Analyte

An analyte is a weak base and its structure is made from any compound that can be converted to a strong acid or base

2.5.6 Titrant

The titrant is a strong acid or base item, is slowly added to the analyte until it reacts. Any visible change in this color of the solution under observation is end point

This is your hint to know if this analyte has reached the minimum amount that is allowed to react with titration

2.5.7 Indicator

Using a pH manner added to this analyte that triggers any change in color when equilibrium is reached, it SLD have a weaker acid/base concentration than the analyte.

2.5.8 Significance

Volumetric analysis is applied to laboratory tests for analyzing and explaining the chemical change taking place inside our body, this a test for understanding the complex patterning of animal acid and its DMA- reacted behavior

2.5.9 What Is A Laboratory Appratus

Using a successful laboratory which is fully equipped with appropriate apparatus spanning all branches of chemistry. Equipment used to measure, weigh, gather, observe, analyze, sterilize or heat data, understanding proper uses for each piece of apparatus is essential.

2.06 Prior Exposure To Laboratory Apparatus

In chemistry Education prior exposure to laboratory apparatus strategies is a distinctive styles of instruction with evidence: prior exposure create expository lessons that make both the students and the teacher to be conscious of the expected outcome and helped students to apply a general principle to understand a specific phenomenon.

Prior exposure create learning environment for the learners to define the topic, in relation to the prior exposed laboratory apparatus and directs learner action. This helped the learner here to follow the instructions and procedures stated in learning chemical concepts in details.

Prior exposure to laboratory apparatus is capable of helping learner to achieve scientific process skill and make exercising, observation, manipulation and data gathering skills real. This provides the learner with freedom to allocate tasks, generate a feeling of ownership and give sense responsibility. So the appearance of enthusiasm and cooperation is an evident bonus. This will make learner to be able to operate and manipulate so many laboratory apparatus for different laboratory activities in learning of different chemical concepts, achievable. To motivate, by stimulating interest and enjoyment is one of the reason given by teachers for engaging in practical activities in chemistry.

Hodson (2006) says that "motivation is not guaranteed by simply doing practical activities; we need to provide interesting and exciting experiments and allow learners a measure of self directed investigation". He added that learners need an interest in and commitment to the learning tasks that conventional class room teaching work of chemical concepts with lecture method does not provide. That commitment, he says, came from personalising the experience by prior exposure on the conceptual aspects of the experiment by identifying for oneself a problem that is interesting and worth investigating. These makes the researcher to be interested and want prior exposure to laboratory apparatus strategy to be a design procedure to be adopted as remedy for poor academic achievement and retention ability in learning of chemical concept in chemistry among senior secondary students.

2.07 Laboratory Apparatus and the Acquisition of Process Skills in Science.

Science engages in procedure of investigation to gain knowledge of natural phenomena. These tactics and strategies, the skill scientists use in their pursuits of understanding are called science processes Kerr (2003). There is however general believe among science education that the development of science process form part of attainment of the general objectives of education. This is because the acquisition of science process on laboratory apparatus plays vital roles in scientific activities Akinmade (1992). They are often seen as the foundation of scientific inquiry since they can be generalized and are require for learning the facts concepts and principles necessary for making valid inference. Gagne (1968) a reknown psychologist believed that a pre- requisite knowledge of concepts and principles could be obtained only if the student has certain underlying capabilities such as the science processes which are needed to practice and understand the concepts of chemistry as a science subject.

Hence process skills are acquired capabilities that can be learned through experience and applied further understanding of nature and problem solving. They are categorized into basic and integrated process skill. The basic science processes include: observation, measuring, inferring, predicting classifying, collecting and recording data. The integrated science processes or process skill is comprised of interpreting data, controlling variables, defining operationally formulating hypothesis and experimenting. Observation is consider to be the fundamental skill by virtue of its position at the foundation of the skill needed to discover the broad knowledge required for inquiry. Shaibu and Mari (1997) share a similar view that the acquisition of science skills ought to be a major goal of education more so that the search for scientific knowledge is process - oriented.

Some of the major features of the processes of science is identified by Firleg (1983) include:

- Each process is generaliseable (transferable) across content domains and contribute to rational thinking everyday affair.
- Each process is an identifiable behavior of scientist that can be learned by student
- Each process is specific intellectual skill used by all scientists and applicable to understand any phenomena.

The processes are hierarchically organized with the ability to use each upper level process dependent on the ability to use the simple underlying process Oloyede (2013). These science process skills have been identified as having the enduring quality of enabling the individual acquire and process information and solve problems even when the information base changes Bybee (2009).

This view apparently supports Wuyep's (1996) notice that concepts and contents of science will undoubtedly change but the mental skills of scientists or the students, which are very vital in science and technology, do not.

The significance of the science process skill maintained Nwosu (2011) has led to the expansion of the goal of science education to include an understanding and development of these process skills in the students. School therefore ought to emphasize the needs of laboratory apparatus on the development of skills in all areas of the curriculum although the types and levels of skills acquisition will depend on learning stage of development. Possession of such skill according to Akpan (2012) is apparent, if students can take action to find appropriate information and techniques from the previous experience and bring them to bear new problems and situations. Some of these process skills are:

2.7.1 Observing

This is the first stage in inquiry. It is made on particular event and general principles are developed from a number of specified and consistent case Abdullahi (2007). It is considered to be the fundamental skill by virtue of its position at the foundation of the hierarchy of process skills needed to discover knowledge required to conduct inquiry. Eniayeju (2012) described it as the skill of looking and seeing which may be made directly or indirectly. The active use of the senses during the process of observation according to Ogunleye (2011) enables one to determine the quantity and quality of things and event. Observations are influenced by past experiences often involving instrument (micro, telepericope etc.) and requiring careful recording and description Karen (1998).

However, Akpan (2012) identified three broad proficiencies that are logically necessary for achieving observational competence to include:

- Making observation well
- Reporting observation well
- Assessing report of observation.

The more precise an observation is according to Mari (1994) the more valid are the inferences based on it. Another important process skill is measuring.

2.7.2 Measuring

Measuring involves assigning numbers to objects or events that may be arranged in a continuums according to set of values and expression of observation in quantitative terms adds precision and permit more accurate descriptions Kerr (2003).

According to Eniayeju (2012) measuring employs the use of counting skills to man made units of length, area, volume, weight and time. The units are initially those developed and applied by the students themselves. It is a process which involves the use of instrument to determine the quantitative value associated with the properties of an object or event Akinmade (1992), Ogunleye (2011).

Mari (1994) identified seven-sub process involved during the process of measuring these are:

- Ordering object by inspection in terms of magnitude of selected common properties such as linear dimension area or volume.
- Comparing quantities such as length, area volume and weight to arbitrary unit
- Taking measurement of quantities which depend upon more than one variable.
- Taking measurement using standard units' more than one variable.
- Converting from one system of unit to another
- Using and devising indirect means to measure quantities.

To be proficient in the use of the process of measurement according to Akinmade (1992) students should be able to measure time, rate of change of a property of an object, represent an object by scale diagram, draw an accurate map and be aware of the limitation of the various measuring devices in use. In addition, students should be able to determine the area and value of one, two or three-dimensional objects. Another important process skill is classifying:

2.7 .3 Classifying: -

Classifying object according to Mari (1994) involves sorting and arranging objects according to their similarities and differences. During this process things or events are organized, categorized and grouped, easily recognized pattern. Akinmade (1992) identifies six characteristics of a student who attain certain level of competence in using the process skill acquisition laboratory apparatus in classifying. Thus the student is able to:

- Determine with reason an appropriate property and categories objects or system of objects according to their property.
- Classify object or systems of objects according to two or more given simultaneous properties
- Select and satisfy two or more appropriate simultaneous properties and group objects or systems of objects on the basic of those properties.
- Identify the properties on which a given set of objects has been grouped,
- Regroup a given set of objects or systems of objects using a rational procedure.

Eniayeju (2012) sees classification as a process and skill of sorting, grouping and ordering objects by both their quality and quantity. The desired goal in this scientific process is for students to develop sensible reasons as a base of their grouping, sorting and ordering. Another important process skill is inferring:

2.7.4 Inferring:

Inferring as perceived by Ogunleye (2011) is a skill of basing judgment in observed and measured event. Smith and Welliver (1990) sees it as an interpretation of one's direct observation. Past experiences are generally used as a basis for interpretation. According to Eniayeju (2012) inference implies the cause and effect relationship, which may be based on preliminary or sketch data or very well founded data from experiment.

Mari (1994) pointed out that inference is strongly made on the bases of inductive and deductive logic. Deductive inference involves reasoning from general premises to specific instance, while inductive involves deriving general preposition from the evidence of specific cases. The following sub processes are involved in the process of inferring as identified by Mari (1994) are

- Distinguishing pertinent observations upon which given inferences are based and are extraneous.

- Drawing an inference from a set of related observation.
- Stating causes and effects relationship from observations of related events.
- Identifying and extending inference to include discrepant event.
- Modifying and extending inferences to include discrepant event.
- Developing plans to test the validity of inferences.
- Using inferences from a set of observations to confirm events. Another important process skill is predicting.

2.7.5 Predicting:

Making prediction according to Akinmade (1992) involves figuring what future observation will be on the basis of available previous information. Identifying some proficiency associated to a person, which achieve competence in using the process skill acquisition prediction. On laboratory apparatus, Akinmade (1992) suggests that such a person should be able to

- Find out and explain trends in a given set of data
- Device appropriate procedures for checking the correctness of the prediction made
- Present plausible argument and evidence to justify his prediction
- Appropriate the importance of multiple observations in making predictions,
- Exercise restraint in making predictions in the absence of reliable and valid multiple observations.

Wellington (2008) sets the skill of predicting as at the process of determining or anticipating future event based on past observations and experiment. To Eniayeju (2012) predicting is a scientific process which arises from a well founded basis of hypothesis, theory or law with regularity, consistent data is hard one to predict. According to Ogunleye (2011) and Mari (1994) predicting involves forecasting or extrapolating on the basis of past observation. Another important process skill is collecting and recording data:

2.7.6 Collecting and Recording data

This is the process skill of transmitting acquired information from one person or group to another, which may result in change in behavior. A scientific experience in observation, data collection, discovery etc According to Eniayeju

(2012) there is need to communicate to other people. This will give growth to knowledge, and it could be in written words, diagrams, graphs or models. However, the following sub processes are involved during the process of collecting and recording Mari (1994).

- Describing observation verbally
- Describing conditions under which observation are made
- Recording observation in a systematic way
- Stating questions and hypothesis concisely
- Using table and graphs to communicate data
- Planning for communication of procedures and result as an essential part of an experiment.
- Reporting experimental procedures in a form so that other persons can replicate the experiments.
- Using mathematical analysis to describe interpretation of data

The above process skills was intended to see if students will be able to acquire them to manipulate laboratory apparatus and what influence would it be on their performance and retention ability.

2.08 Studies on Students Academic Achievement in Practicals

Inquiry and discovery learning had received so much attention through the science curriculum study designed by Still Water (2013). It is necessary to distinguish inquiry learning from discovery learning for this purpose of discussion. Inquiry approach to learning is considered to be the welding of "process to content" the sequential development of skills that will produce a maximum level of autonomous search behavior in individuals.

Sund and Trowbridge in Anderson (2011) put it simple by saying that inquiry built on discovery. They contend that in true inquiry the individual acts as a nature scientist.

The discovery apparatus stresses active investment, through direct manipulation of the hardware of science. In the secondary method the students develops the following cognitive processes: observing, classifying, measuring predicting, describing and inferring.

So, the process skill approach method have important parts to play in chemistry and science generally but the method can be executed without appropriate and adequate laboratory apparatus.

The "science process skill" is essentially scientific method of pursuit of knowledge. The use of tools, acids, laboratory apparatus and facilities help scientist of such tools may ultimately lead to a break in wilson model and consequently the scientist will not obtain the desired result in the same view the use of laboratory apparatus in secondary schools aid the learners to be familiar with the "science process skill" and to achieve results within the scope of his ability and competences.

Bruner (1961) in Bogner (2012) stated that, Of only one thing I am convinced I have never seen anybody improve In the art and technique of iniquiry by any means other than engaging In process skill approach. Jegede (2003) and Abah, (2009) both Nigerian educationists share Bruner's view that students can learn to use science skill approach through teaching and learning science by use of laboratory apparatus. They both expressed the view that if Nigerian students are to become capable of finding out new facts with the truth, they need to be given a chance to develop the habit of process skill and of practical investigation. Such investigation activities can mainly be done by the use of adequate and relevant laboratory apparatus.

Johnson (2009) in line with the assertion of Bruner, Abah and Jegede with his research conducted to compare the following three teaching situations,

i.) Teaching by a traditional textbook method without laboratory apparatus

ii.) Teaching with a combination of textbook and supporting laboratory apparatus

iii) Teaching in an activity centered open ended process skill situation.

In this study therefore prior exposure of students to laboratory apparatus will be investigated in relation to academic performance in chemistry at senior secondary school level.

One of the implications of this investigation is that teachers who are interested in the positive attitude of their students toward science should have concrete materials i.e. laboratory apparatus to work with. The method of teaching and learning science had changed drastically from the fundamental textbook approach to the science process skill on laboratory apparatus approach. There are other shifts of emphasis in science teaching. According to Hodson (2006) some of the changes include Concept formation and systematic thinking as against rote learning and memorization. Laboratory experiments are now designed to raise problems test process skill and provide opportunities as against laboratory demonstrations on verification of known information.

There is more evidence of studies to indicate the effect of science process skill on laboratory apparatus methods in science teaching in Nigerian school. Students and publications elsewhere indicated values inherent in this methods. If the Nigerian student is to derive greatness in chemical educational values, he should be given the tools with which to work in the laboratory. He needs the opportunity and material necessary for the interpretation of observation and data. He should be helped develop fully the process of science skill. The emphasis of teaching is now of learner centered approach rather than by demonstration, lecturers and textbooks. In this context, the learners should be provided with material so that they can have a degree of independence in their learning enterprise. Johnson (2009) observed that in schools where facilities are inadequate chemistry is usually taught theoretically. He observed further that this approach does not assist students to develop the correct experimental and process skill acquisition to the study of science. It does not help them to acquire various practical skills.

2.09 Students Retention Ability in Chemistry.

Several studies have been carried out on students retention in chemistry concept. Erikson (2005), found that laboratory apparatus skill differs from cognitive ability levels, those with high retention performing better than those with low retention. Other studies that used different methods like brainstorming technique teacher directed and self-directed and individualized instruction and teacher-centered methods did not find any significant difference in the laboratory apparatus behaviour of experimental control group. Reports of Krulik (2010) from experimental studies confirm that regular instruction plus laboratory apparatus resulted in more retentive learning than those without laboratory apparatus. Specifically in science like chemistry, Abah (2003) study showed that in those Nigeria secondary school where chemistry teachers made appropriate use of laboratory apparatus, students obtained higher academic performance and retention ability in chemistry scores at senior secondary school level.

A study by Kwon, Allen and Rasmuseen (2005) aimed at investigating students retention of mathematical knowledge and skills in two differential equation classes. Posttests and delayed posttests after one year were administered to students in inquiry-oriented and traditional classes. The results showed that the students in the inquiry-oriented class, when compared with those in the traditionally taught class retained conceptual knowledge as manifested by their performance on modeling problems better than those in the traditionally taught class. They however retained equal proficiency in procedural problems. The result adds additional support to the claim that teaching for conceptual understanding can lead to longer retention of mathemacal knowledge.

In a study which included retention treatments, Ikedolapo and Adetunji (2009) compared the relative effectiveness of the guided discovery and concept mapping teaching strategies in relation to students performance in chemistry. The study sample comprised a total of 360 SSS chemistry students who had registered for Senior Secondary School Certificate Examination (SSCE) from four secondary schools in Bauchi Local Government Council of Nigeria. The t-test statistic was used to analyse the data obtained and the results indicated that there was no significant difference in the mean scores of the students due to post posttest (retention) treatments. It was also observed that gender made no significant difference when the mean scores of the methods adopted were compared on the post posttest (retention) treatment. They concluded by stating that the outcome implies that both methods were equally powerful in terms of improving students achievement in chemistry.

A non-equivalent quasi-experimental study to determine the effectiveness of Ethnomathematics Teaching Approach (ETA) on students achievement and retention in Locus was carried out by Achor, Imoko and Uloko (2009). Results from a 2-way analysis of covariance (ANCOVA) reportedly revealed that students exposed to ETA were superior in achievement and retention than those taught with conventional approach. The aforementioned studies have shown that the prior exposure to laboratory apparatus strategy employed in teaching concepts to students had effects on both the achievement and retention ability of subjects.

2.09 Gender - Related differences in Learning of (Chemistry) Science

Several studies have been carried out on the gender difference in teaching and learning of sciences, Johnstone (2006) reported that male and female students did not achieve equal competence in science and mathematics Okeke (1980) found no significant different in the performance of boys compared with girls. A small gender related difference in science achievement among 13years old or early adolescent was found by Adams (2006). Brain and Allan (2007) on their finding reported that boys performed better in science than their female counter parts. In a related research. Abah (2009) conducted studies, which showed boys were interested in physical science while girls' preferred biological sciences. Also Oriafor (2002) found that female students performances on the average were poorer in all domains examined.

Gunstone (2011) examined the relationship between gender and eight scale of cognitive ability using Differential Aptitude Test (DAT) normative oath of several years. For the most recent year, 2009, he found girls scored higher on spelling, language and clerical speed while boys' scores higher on mechanical reasoning and space relation. Jegede (2003) have observed a significant superior achievement of boys over girls in integrated science at the junior secondary level. These differences in achievement between boys and girls according to Jegede (2003) may be due to the varying tasks performed by boys and girls in their early years and therefore are insignificant. He went further to explained that severe limitations on young females in the performance of science process skills at the schools on laboratory apparatus may have an effect on the ease with which they learnt science and consequently the reluctance of the majority of female to actively engage in science and related courses.

Shemesh (1990) conducted a research on gender related differences in reasoning skills and learning interest of senior high school students and discovered that adolescent boys develop patterns of formal reasoning before their girls counterparts. The result also indicated that boys tend to prefer science and technology subjects, while girls tend to prefer language, social studies and humanities. The boy's choice of science and technology subject was resorted to have a direct correlation with age and development of formal reasoning, while girls choice of language, social studies and humanities has an indirect or inverse relationship with age and a direct relationship with the development of formal reasoning ability. Meester and Maskill (2004) reported that gender differences in science achievement occurs as a result of a number of social factors both at home and at school, and that gender differences appear to be greater in some schools than in others, although statistically significant gender differences in chemistry achievement were also found among year 12 chemistry students favoring boys. There were statistically significant sex differences in physics achievement among students from all age groups. However both male and female students appeared to achieve higher physics scores to move advantaged home background Meester and Maskill (2004)

Olarewaju (2004) reported insignificant differences between boy's and girl's achievement in the knowledge of biology concepts. Boys in this report were found to achieve better than girls. Dahiru (2004) also conducted a research on the relationship between gender and the selection of science subject in Katsina local Government Area. His result revealed that there is no significant relationship between gender and selection of science subject in the area under consideration.

Adegwe (2000) attribute differences in the learning ability of boys and girls to socialization process because girls are denied out of school and pre-school experience in problem solving especially those involving visual activity behaviors that inhabit the development of math's and science capability in girls. How ability in girls' performance could be enhanced when they are adequately exposed to science related activities.

This study therefore intends to see what will be the gender differences on the acquisition of science process skills based on laboratory apparatus exposure of chemistry student at senior secondary school level.

2.10 Gender Related Differences and Laboratory Apparatus on Process Skills Acquisition.

For science teaching and learning to be interesting and meaningful, the development of science skills in using laboratory apparatus in students should becomes a necessary and integral part of school science curriculum.

Nwosu and Okeke (2009) observed that any meaningful learning of science by students in Nigeria secondary schools must include the acquisition of science process skills and the science curricula were modified to reflect this emphasis when these process skills are acquired, intellectual ability of the students is widened and this could be used for life in the understanding of nature and problem solving. This is true and as rightly observed by Kerr (2003) that "Give a man a fish and he eats for a day, teach a man to fish and he eats for a life time". The process skills are the tools such as laboratory apparatus for learning and problem solving. They should not only be acquired at all level of our school, but should also be acquired to a reasonable extent Nwosu and Okeke (2009), even though literature on the acquisition of these important process skills in relation to gender and laboratory apparatus is deficient Nwosu (2001) and Johnson (2009).

Johnson and Murphy (2008) reporting data collected from the Assessment of Performance Unit (APU) in the United Kingdom (UK) who indicated that girls show superior performance in observational skill at all ages tested (11, 13 and 15 years). The report suggests that girls out performed boys with respect to questions that require objects or features to be compared and contrasted but that the reverse trend to seen with respect to questions where scientific explanation of observation are required. Girls were however found to out performed boys in relating to reporting observations of colour-changes in chemistry context Ben-Wi in Al-shuaili (2009). On manipulate skill, Scottish data Erikson (2005) suggests girls show significantly superior performance to boys.

Data collected from low achievers aged 15-16 years in Scottish schools on the skills of measuring Erikson (2005) indicated that no gender related differences were found for using lenses or stop clock but that girls were better at focusing of microscope than boys. Report on the skill of interpreting data Johnson and Murphy (2008) indicated that at age 11, there are no gender - related differences in performance of interpretation but that at age 13, boys' slight superiority is evident, but by age 15 these differences reach statistical significance which they said may be related to the greater proportion of coordinate graphs used with these ages.

Research conducted by Al-shuaili (2009) on gender and practical skill performance on science indicated that there is no gender difference in observation, reporting or planning skill and there was no differential performance in the use of scientific language. The report also indicated that boys performed better in interpretation than girls.

However, report by Mari (1994), Shaibu and Mari (1997) revealed that there was significant difference between the male and female subjects in their ability to solve problem requiring their understanding of the process skill as pre-requisites but the female subjects were significantly better in their understanding of science process skills than their male counterparts.

A study conducted by Ameh (1980) to determine the influence of sex upon the acquisition of science process skills revealed that boys were better at using numbers measuring and experimenting than girls, while girls performed better in the process of observing and informing. However, the overall mean score of girls in both Integrated and Basic Science process was found to be higher than that of the boys. Similar result was obtained by Usman and Uhal (2007). Nwosu (2001) in her study revealed that exposes to science process skill based learning involving activities for both girls and boys (experiment group) yield a more effective learning irrespective of gender and ability level. Report by Danladi (2003) also revealed no significant difference in achievement between girls and boys on the involving process skill acquisition. There is thus, the need to use activity - based learning in schools to help prisoners especially girls who are denied these opportunities at home to acquire the process skills.

Nwosu (2001) suggests that gender stereotyping has to be discouraged in the home; school and societies to enable girls participate freely in skill-based activities.

2.11 Overview of Similar Studies

When a student comes into the classroom or laboratory to learn science, he or she does not have a blank mind. He has some form of "library" of knowledge, though rather rudimentary, incomplete or sometimes faculty to be refined and or consolidated. This reason calls for the need for instructors to consider students prior knowledge in teaching of any science subject. As we live under the extraordinary influence of science and technology, it has been recognized at global level that developing countries must consider the science and technology properly for their educational institutions (Chem, 2000). The relationship between science and technology becomes more complete if their impact on the society is taken into consideration thus giving a more holistic view to science and technology education (Alamina, 2001).

Efe (2012) investigate the effectiveness of laboratory and lecture instructional strategy on student's achievement and retention in some selected topics in SSCE Chemistry using 120 students with an average age of 17 years which were randomized in two treatment groups. Constituted the sample size for the study. The chemistry achievement test CAT and chemistry retention test CRT were used as post - test for the study. Data were analyzed using mean X, variance S^2 and stranded deviation (S.D) and the result reveals that among others, the experimental group taught by the laboratory instructional strategy performed better than the control group who were tough using the lecture teaching method

Oloyede, (2012) investigate the relationship between acquisition of science process skills and achievement in chemistry using 320 S.S. II senior secondary school students from Bauchi State Nigeria. The researcher used test of logical thinking test on process skills and the students S.S.I examination result in chemistry as instruments for data collection. The data collected were analyzed using Product Moment Correlation Co-efficient and result reveals that positive relationship exists between formal reasoning ability and acquisition of process skills, formal reasoning and chemistry achievements, acquisition of science process skill and chemistry achievements.

Ekene and Ifeoma, (2011) carried out a study to identify students' perceptions of factors influencing acquisition of process skills in chemistry using 440 S.S.I chemistry students from Ogidi zone of Anambara State. Questionnaires were use for data collection and the data were analyzed using z-test statistic. Result revealed that students do not have enough time for their class work and their course materials are not covered due to broad curriculum, lack of quality Science teachers and large school population.

Ajoke and Joe, (2012) Used 40 S.S. II students in Ogu-Bolo Local Government Area of River State to investigate the effect of Demostration approach of teaching chemistry on creativity and process skills for self-reliance. The research instrument use for collecting data were creativity ability test and Science process skill acquisition test which was analyzed using t-Test. Result revealed that high, average and low creative ability students performed significantly better when taught using the student-teacher demonstration approach than those taught using teacher demonstration approach.

Erden, (2012) carried out a research to examine the changes in attitude towards chemistry in Turkey. The study comprises of 29 students in their 4th class of teaching. A scale of attitude towards chemistry and the test anxiety was used as instruments for data collection and correlation analysis was used to analyze the data. He find out that low and insignificant relation was observed between the attitude- academic performance, anxiety- academic performance and attitude- anxiety of students. Also, an inverse relation was determined between attitude and anxiety scores.

Chemistry is often regarded as a difficult subject for students (Johnstone, 2000). The assessment of students understanding scientific concepts has been of interest to researchers and teachers in the science education community recently (Gunstone & Woolnough 2011). Esiobu and Soyibo (1995) reported that students constructing concepts maps in cooperative groups show a greater increase in conceptual learning than that students working individual. Many students reported to have trouble with the conceptual nature of chemistry.

Science educators have become increasingly aware of the importance of students' preconception of some findings from the research on children's ideas in science education. Children have ideas and views concerning many science topics even at a young age and before any formal education on the subject. Children preconceptions often show remarkable consistency across diverse populations. They influence children's understanding of the scientific conceptions presented by their teachers, who were frequently unaware of the existence of such views.

"I know about this" or "I've seen this before" most children used what they knew (or thought they knew) as a basis for their predictions sometimes helpfully, sometimes not. According to Gunstone (2011), students assimilate information by using information to differentiate among existing concepts. Students are not like blank slates or sponges ready to absorb knowledge nor are student performance simply as a result of innate ability or of rich experiences.

Helping student acquire new knowledge, integrate it with what they already know and retain it, is an important aspect of learning. Since ancient times educators have been interested in pedagogical theories and ideas about how human beings think and learn. They also outlined some steps for successful learning that teachers must follow is students are to learn materials or acquire new mental state (Marizano, Pickering and Mctighe, 1993). First is the preparation of bringing into consciousness for mental impression of prior exposure that are going to be relevant to the new information. Secondly, new materials or concepts presented. Thirdly, new ideas are compared and abstracted or associated to the former materials or mental states. Fourthly, generalization that incorporated both old and new information is formed. Finally, the expanded concept with its element of old and new is applied. They combine the first and second and called it clearness, the third association and fourth system and application as method. Adams (2006) says that student's interest is very essential in learning, if new material is associated with former mental states, the new will naturally be interesting thus is a new idea that can naturally be associated with old ideas students will feel interested.

Roselyn, Samuel and Joel, (2013) investigate the effectiveness of science process skills mastery learning approach on students' acquisition of practical skills using 160- form two students from 4-co-educational schools in Koibatek district in Kenya. The researchers used Science processes skills performance test and classroom observation schedule as the research instruments for data collection and the data were analyzed using mean, ANCOVA, ANOVA and standard deviation. Result revealed that students in the experimental group outperform students in the control group in the acquisition of some selected chemistry practical skills.

Chemistry subject at secondary level contains various topics, some of these are considered as difficult by various students. For current research only two topics were selected to observe the prior exposure to laboratory apparatus and these topics were the method of separation techniques and volumetry analysis is not only a fundamental unit of measurement but it is also an important foundation for more complex chemical concepts such as Stoichiometry concentration of solution, the equilibrium constant and PH. If students are to construct accurately and frame out clearly, It depend and as well connected to conceptualization of the volumetric analysis. The volumetry analysis then is a cornerstone to building a successful understanding of domains specific knowledge. If the students don't have the background on method of separating techniques and volumetry analysis, their chemical problem solving ability will be severely limited (Usman & Ubah 2007).

Adigwe (1992) conducted a study titled Three Problem-Solving Instructional Strategies and their Effects on Nigerian Students' Attainment in Chemistry'. The samp[le consisted of 400 subjects (range 16-25 years) randomly drawn from four senior secondary schools in Delta State, Nigeria. The researcher concluded that Selvarantham model instructional approach is one of the useful for teaching chemistry problem-solving in senior secondary schools in Nigeria.

Hsi-Chi and Jen-chai (2003) carried out a study titled quasi-experimental study researching how a problem-solving instructional strategy impacts on learning outcomes on engineering students. However, there was a significant difference in problem-solving confidence on the attitude scale. There were significant difference between the experimental and group and the control with regard to the factors of repair and replacement, diagnosis and testing, as well as the strategy application of scale of the problem-solving ability. The result showed that the problem-solving instructional strategy help increase their problem-solving attitude abilities.

Bichi (2002) also investigated the effects of problem-solving instructional strategy (paired problem-solving instructional strategy) and enriched curriculum on secondary school students achievement in evolution concepts. The subjects in the experimental and control groups were taught evolution concepts in historically enriched curriculum using the problem-solving instructional strategy and their achievement were compared with that of the control group who were taught same concepts using the conventional biology curriculum alongside the traditional methods.

Pre-test and post-test data were analyzed to determine the effectiveness of the two instructional strategies and the two curricula. Seven hypotheses were tested using the t-test statistic and the following major results were obtained. Students exposed to problem-solving instructional strategy achieve significantly higher than those exposed to traditional method of teaching.

Students exposed to problem-solving instructional strategy retained the learnt concept significantly better than their counterpart exposed to traditional instructional strategy. There was no significant difference in students' achievement with reference to the following variables regarding gender and problem-solving strategy; gender and traditional method; gender and historically-enriched curriculum and gender and conventional biology curriculum. In line with the above report Bichi (2002) investigated students performances using paired problem-solving in evolution on secondary school students.

Jibrin, Zayum and Abba (2011). Investigated the Effects of Enhanced Problem- solving Instructional Method on self-efficacy of Senior Secondary School School of Biology students' in Bauchi Metropolis, The researchers employed Quasi-experimental one group pretest posttest control group design. The population of the study was all the fifty (50) Senior Secondary School that were located in Bauchi Methropolis with the total of 10,500 Senior students. They comprised both private and public school. Two (2) Senior Secondary School were randomly selected from the area of the study. Fifteen (15) items of 5 Likert points self- efficacy Test (ST) was developed by the researchers and employed for data collection. The instrument (Self-efficacy Test) was validated by two (2) PhD holders and senior lectures from Educational foundation Programme (EFP) ,ATBU Bauchi and two (2) B.Ed hodlers and Senior Secondary School Biology teachers and has a reliability coefficient of r=0.65. data was collected and subjected to t-test statistics at $P<0.05$. The result indicated that the calculated value 2.56 recorded is greater than the critical value 2.04 in favor of the experimental group, therefore the null hypothesis which states there is no significant difference is rejected in favour of the experimental. It was concluded that enhanced problem-solving teaching strategy is one of the method for developing self-efficacy in learners. Since students who received instruction through it have higher self-efficacy mean scores than students taught biology using lectures method. It was observed that if the right instructional method such as enhanced problem-solving teaching method is employed. Self-efficacy of senior secondary school students in biology can be improved.

Yadav and Mishra, (2013) compare the effect of laboratory approach on university students' development of science process skills and conceptual achievement using 40 Shrikanwarata public schools students in Mandleshwar. The researchers' used science process skills test and force concept inventory to compare skills and conceptual achievement of both the control and the experimental group students'. The data collected were analyzed using mean, standard deviation and t-test. Result revealed that the achievement of the students who were taught using the laboratory approach was significantly higher than those who were taught using traditional approach and the development of process skills were higher in the students who were taught using the laboratory approach.

This study therefore attempts at looked at the impact of prior exposure to laboratory apparatus on the understanding of these chemistry concepts in Nigeria secondary schools as per a great concern to many scholars especially science teachers, parents and educators over the years.

2.12 Implication of Literature Reviewed on the Present Study

The literature reviewed indicated that science is poorly taught in most of the Nigerian secondary schools. This implies that the present study should strictly adhere to the modern form of science teaching in which students will actively be involved as stipulated in the laboratory apparatus on the science process skills acquisition curriculum

Most of the literature reviewed also revealed a low level of science process skill acquisition on laboratory apparatus among students in secondary schools. However, applying traditional lecture method along side with process-oriented approach will help in identifying which among these methods greatly enhanced science process skill acquisition on laboratory apparatus among students. The literature also indicated strong gender indifference among students taught using teaching method which did not emphasize students' active participation. This implies that the use of process-oriented approach could help in determining whether the approach is capable of eliminating gender related differences among students or not.

Most of the researchers conducted on the process approved as revealed by the literature reviewed was based on acquisition of skills without laboratory apparatus exposure. This implies that it is also pertinent to conduct a research to cover the use of laboratory apparatus on science process skills approach or students as intended in this study to see what the result will be.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This study is aimed at investigating the impact of prior exposure of laboratory apparatus on science process skills acquisition, achievement and retention in chemistry among senior secondary school students (SS2) in Giwa Educational Zone of Kaduna State. In this chapter, the methodology is presented under the following sub-headings:

- Research Design.
- Population of the Study.
- Samples and Sampling Technique.
- Instrumentation.
- Administration of Treatment.
- Data Collection Procedure
- Data Analysis.

3.2 Research Design

A Quasi - experimental - control groups involving pre, post and post-post test design was used for the study, because the researcher has not total control of study subjects. Pretest was given to experimental and control groups using CAT and SPSAT in order to test that there is no significant difference between the two groups ability level before the treatment. This is according to Kerlinger (1973) and Akuezuilo (1993) involves two groups in which one group was assigned as experimental and the other the control group. Pretest was given using the some Chemistry Achievement Test (CAT) as well as Science Process Skills Acquisition Test (SPSAT) were use in testing the equivalence of ability level of the study subjects before exposure to the treatment.

Experimental Group (EG) is the group that were taught using the prior exposure to laboratory apparatus on acquisition of process skills while the Control Group (CG) were taught the same chemical concept but restricted to classroom environment without prior exposure to the laboratory apparatus strategy.

In the course of this research work, the Experimental Group (EG) and the Control Group (CG) were pre-tested to ascertain that there are not different significantly in the ability level before their level of understanding of the use of laboratory apparatus prior to teaching of chemical concepts to see their acquisition on process skills level before and after administration. Later, a post-test was administered after four weeks treatment to both the experiment and control groups as recommended by Tuckman (1975). The post-post test treatment was given two weeks after the post test to test the retention ability of both groups. The pre-test which involve CAT and SPSAT was given after treatment administration. The research design illustration is presented in Figure 3.1

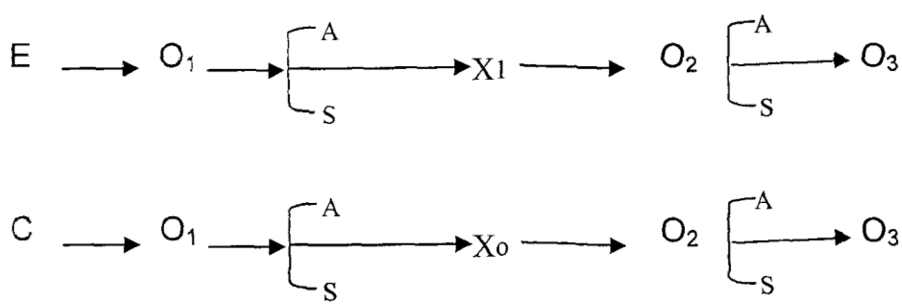

Fig 3.1 illustration of the Research Design

Key

E	=	Experimental group
C	=	Control group
X_1	=	Treatment on prior exposure to laboratory apparatus
X_0	=	Treatment on Not Prior exposure to Laboratory Apparatus
O_2	=	Pre - test using CAT and SPSAT
O	=	Post - test using CAT and SPSAT
O	=	Post - post test using CAT and SPSAT
S	=	Acquisition of Science Process Skills
A	=	Academic Achievement.

3.3 Population of the Study

The target population of this study involved 996 SS2 students of the Government Senior Secondary Schools located within Giwa Educational Zone of Kaduna State. The schools were selected because they are the only science schools in the zone and similarly have the same laboratory apparatus in their laboratories which are in line with the objectives of the study

The average age of these students was 15 years. The senior secondary two (SS2) were selected because they have had one year of chemistry class and also have one more year ahead. The population of SS2 chemistry students in the different secondary schools were summarized in Table 3.1

Table 3.1: Population for the Study

S/N	Name of School	Ownership	Number of SS2 Chemistry M	F	Total
1	Dr. Shehu Lawal Giwa G.S.S Giwa	Government	-	82	82
2	Government Secondary School, Kudan	"	63	34	97
3	Government Girls Secondary School, Samara (Senior)	"		56	56
4	Government Boys Secondary School, Bomo (Senior)	"	67	-	67
5	Government Girls Secondary School, Bomo (Senior)	"	-	43	43
6	Demonstration Secondary School, Samaru (Senior)	"	111	70	181
7	Dr. Yusuf Aboki Secondary School, Shika	"	41	22	63
8	Government Secondary School, Fatika	"	37	21	58
9	Government Secondary School, Yakawada	"	31	18	49
10	Government Secondary School, Bassawa	"	42	19	61
11	Government Secondary School, Shika	"	30	13	43
12	Government Secondary School, Kwangila	"	37	20	57
13	Government Secondary School, Giwa.	"	41	28	69
14	Government Secondary School, Hunkuyi	"	50	23	73
	Total		**547**	**449**	**996**

(Source: Giwa Educational Zone Record File 2011)

The Government schools in Giwa Educational Zones were used. Two Government secondary schools were deeply involved in the research (Government secondary school Bomo) as the control group and Dr. Aliyu Yusuf Aboki secondary school as experimental group). The two schools were selected as they recorded higher chemistry students in Giwa Educational Zone. The whole SS2 chemistry students from both schools were used for the experiment. A total of 120 students were used for both control and experimental group. For the reliability test, the girls and boys of the sample school were randomly selected for the experiment.

3.4 Sample and Sampling Procedures

The sample for this study were SS2 chemistry students in the two Government secondary schools, Bomo and Shika. The secondary schools selected were established the same year by the state government with similar manpower, students population, qualify chemistry teacher, staff and the laboratories.

The researcher used stratified random sampling techniques by employing balloting method in which one hundred and twenty (120) students were selected. The researcher selected sixty (60) students from both schools, totaling one hundred and twenty (120) students for the study. This is in line with Tuckman (1975) that central limit theorem recommended sample size of minimum of 30 subjects is viable for experimental study of this nature. Among the selections, female students constitute 60 and male students 60 making total of 120 study students. The summary of the sample selection is presented in Table 3.2 below:

Table 3.2 Sample Selected from the Study

S/No	**School**	**Location**	**No of students**		**Total**	**Remark**
			Male	Female		
1	GSS	Bomo	30	30	60	Experimental
2	Dr. YAGSS	Shika	30	30	60	Control
	Total		**60**	**60**	**120**	

From 60 study subjects, 30 were males and 30 were females respectively selected from Bomo and Shika as stated previously and they were grouped into experimental and control study subjects respectively using balloting method involving picking from the chat procedure as shown in Table 3.2

Four schools were pretested in order to determine whether they are not different significantly in their ability level before treatment. Selected students in those schools were given pre-test using CAT and their scores were analyzed using analysis of variance. It was found that they were significantly difference in the four schools academic achievement. To determine the schools that are not different in their academic ability level, scheffes test was used. From the scheffes test result, two schools that their score shows no significant difference were chosen for the study in which latter they were divided into experimental and the other control group. Pre test was also administered to the study subjects in order to determine their compatibility after ability level in which analysis of variance (ANOVA) was used on four schools and the results showed no significant difference at $p< 0.05$. Later scheffes test was carried out and there was no significance difference in the ability level of two schools. Based on these, the two schools were selected for the study as experimental and control group.

3.4.1. Selection of Topics Used in the Study

Topics used in this study were the topic that involved the use of laboratory activity and laboratory apparatus. They are as follows

- Separation of mixture using separating techniques
- Volumetric Analysis.

The topics were presented using prior exposure to laboratory apparatus to experimental group and control group using lecture method.

Table 3.3 Table of specification based on topic selected for the study

S/NO	TOPIC	ITEMS	TOTAL
1	Separation of mixture	1, 4, 6, 8, 10, 15, 16, 19 21 22	10
2	Volumetric analysis	2, 3, 5, 7, 9, 11, 12,13	15
		4, 17, 18,20 23 24 25	
		TOTAL	**25**

3.5 Pilot Study

In the pilot testing two tests were carried out (i) reliability of instrument (ii) test or ability level of the sample.

Reliability Test of the instruments

The pilot study was conducted in two schools Namely GSS Bassawa and Demonstration secondary school samara. The subjects used were the SS2 of those schools. The purpose of the pilot study was to ascertain the feasibility and reliability coefficient of the instruments adopted and the students SPSAT. through a trial run. The CAT consists 40 multiple choice items. Instruction on how to answer the questions were read and explained to the students by the researcher. This was done to ensure that the students answer the question items on (CAT) carefully. Based on the analysis of the scores obtained from the pilot testing of the CAT, the reliability coefficient for the test was determined using Pearson Product Moment Coefficient statistic used and r= 0.89 was recorded which was confirmed during the pilot reliability test while the reliability of the SPSAT also using Pearson Product Moment Coefficient was found to be 0.75.

3.5.2 Instrumentation

The instrument to be used for data collection in this research work involve CAT and SPSAT. The instruments were designed as follows:

3.5.3 Chemistry Achievement Test (CAT)

Chemistry Achievement Test (CAT) has to do with the measuring of students competence in chemical concepts. That is to determine students achievement and retention ability in chemistry. Forty items objectives test involving multiple choices of A - D test was used. Chemistry Achievement Test (CAT) was used for pre, post and post - post test. The instruments involve 40 multiple choice items. The marking scheme as the scoring system was provided in appendix (2) and totaling of maximum 40 marks.

The topics selected for instruments constructions are from WAEC and NECO syllabus(2008-2010). The duration for examination was based on pilot test study for the administration. The instruments were subjected to validity, reliability test as well as the item characteristics for the purpose of standardization.

3.5.4 Validity of the Instrument (CAT and SPSAT)

The effects of prior exposure of laboratory apparatus on acquisition of process skills and the laboratory activity method of instrument on academic achievement and retention in chemistry among secondary school students is the focus of this study. Chemistry Achievement Test (CAT) and(SPSAT) with the corresponding marking schemes (Appendix) were validated by 3 Senior Lecturers with Ph.D in Science Education, Faculty of Education, Ahmadu Bello University, Zaria and two Principal Lecturers who major in Science Education at Chemistry Department, Federal College of Education Zaria.

The validators have been required to critically examine and assess all the items of the instrument paying attention to the following:

i. Whether the test items test what are meant to be tested;

ii. Whether the questions are clear, precise and free from ambiguity;

iii. Whether the questions match the ability of the students;

iv. Whether the language of expression is simple and unambiguous.

The experts made constructive criticism and corrections on the basis of content and face validity of the instruments.

3.5.5 Reliability of the Instruments (CAT) and (SPSAT)

To determine the reliability of the instruments, test - retest method was employed. The first test was given to the students of different institutions. After two (2) weeks interval, the second test was administered. In line with Tuckman (1978) recommendation of the use of two weeks interval for the test - retest procedure. Person Product - Moment Correlation Coefficient Statistics was used to analyze the reliability of the instruments. Reliability coefficient recorded during pilot test was 0.89. Therefore, it is reliable and was used for the study.

On the basis of the data that was obtained from pilot testing of the achievement test reliability of the instruments used for this study was determined.

3.5.6 Items Characteristics of the Instrument

For the purpose of standardization of the instrument (CAT) facility and discrimination index were determined as follows:

3.5.5.1 Item Facility Index (F.I)

This is the percentage of the students who obtained the correct answer on items. To compute the difficulty index for each item in the test, the steps are as follows:

- Ranking order of the scores on the test from highest to lowest.
- Identification of the high scoring group and how scoring group. The top scoring over the third of the students and the bottom scoring one third.
- Determine the percentage of high scores and low scores passing an item
- Computation of the item difficulty index by collating the percentage of those correct in the low scoring and high scouring and then divided by the formula P = U + LN

P = Item difficulty

N = number of students involved in the analysis

U = number of students that got item right in the upper %

L = number of students that got item right

Difficulty index of 75% or higher regarded as easy in term of difficulty level where the index is 25% or less the item is hard in terms of difficulty level.

In the Chemistry Achievement Test (CAT) with difficulty index which ranges from 25% to 75% was retained while the discrimination index with ranges from 0.30 to 0.70 was used for the study in line with Inyang (1988) and James (2000). The detail of the scores is presented in the appendix H

3.5.7 Item Difficulty Index (D.I)

This is used to identify high and low achieving students. This difficulty model of test items is the ability to separate or sort out high and low ranking students in a test item showing little or no success in favour of the poor group should either be eliminated or re - examined for vagueness and ambiguity and such items should be rewarded.

Difficulty index for each item is calculated by subtracting the number of students in the lower group who answer the item correcting from the number of students in the upper group who got the item right. The figure is divided by half the number of students in both groups or by the number of students in one of the groups.The difficulty index of the Chemistry Achievement Test (CAT) was determined using the formula given by Inyang (1988) and James (2000).

Thus $D = \frac{Ru-RL}{^1/_2 N}$

Where

D = difficulty index

Ru = number among upper 27 percent of respondents who scored

RL= number among the lower 27 percent of respondents who scored the item correctly

N = number of respondents in each of the upper and lower groups

According to Inyang (1988) and James (2000) items within difficulty index which range between 0.3 - 0.49 are moderately positive. Those with difficulty index above 0.49 are high positive showing that a large proportion of the knowledgeable students are poor students who got the item correctly. For this study, difficulty index of 0.3 - 0.7 were selected and those within very low index rewarded the details of the computation was presented in appendix.

3.6 Administration Treatment

The treatment administration of this study was involve in teaching of separation techniques and volumetric analysis as chemical concept in the chemistry using laboratory apparatus. The students were taught with this concept for six weeks considering 12 periods of 2 hours each. The students were taught method of separation techniques and volumetric analysis by exposing the experimental group to laboratory apparatus and control group to lecture method. Then the following steps were carried out: Before the teaching, the samples were classified into experimental and control groups were pre- tested.

The subjects were taught for a period of six weeks consisting of four hours period per week, i.e. the control groups were taught without prior exposure to laboratory apparatus while the experimental groups were taught with prior exposure to laboratory apparatus.

At the end of the treatment, the study - subject were post - tested using Chemistry Achievement Tests (CAT) to measure any significant difference on the academic achievement of the study subjects and also SPSAT was used to test Science Process Skills Acquisition.

After two week, the study subjects were post post-tested using the same instrument to test their level of retention ability as means of their evaluation as they were evaluated.

The procedure used for teaching the experimental group are

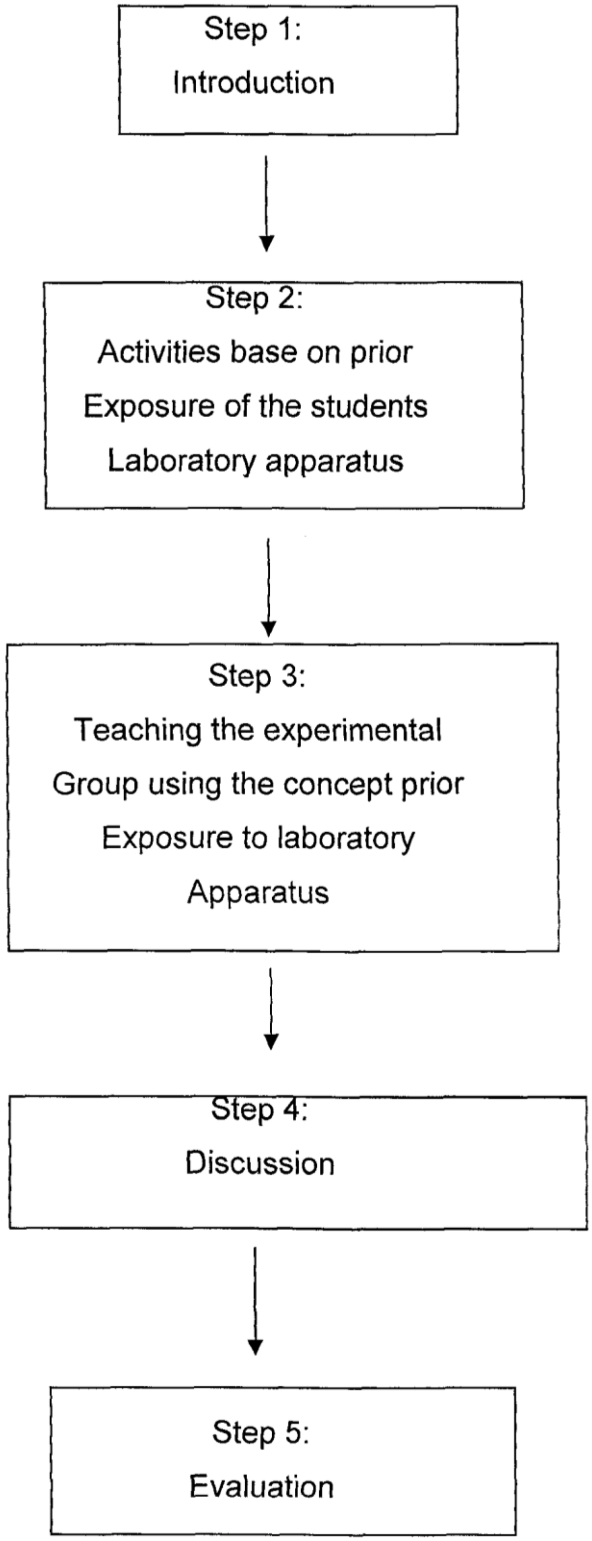

Figure 3.2 Flow Chart of prior exposure to laboratory apparatus steps adopted from Jensen and finley, (1996)

3.7 Data Collection Procedure

Data was collected from the different scores of the study subjects in CAT and SPSAT at different interval of post-test and post- posttest which were in line with Tuckman (1975) to test the hypothesis for this study. The mark scores from the administered CAT and SPSAT at the different interval of post-tests and post-posttest were recorded separately based on CAT and SPSAT for experimental group and control group respectively. The scores were recorded as experimental and control group for both academic achievement and science process skills and retention ability also the male and female based on gender.

3.8 Data Analysis

Research questions 1—4 were answered by analyzing the data collected using descriptive statistics inform of means (x),and standard deviation(SD). To test the hypothesis for this study, the inferential statistics of students' t-test was employed to determine the mean significant difference between the two groups (i.e control and experimental groups). $P < 0.05$ was used to retain or reject the null hypothesis stated. The data collected for the study was analysed by restating the research question and hypotheses as follows:

Research question one

What is the difference in the mean academic achievement of secondary school chemistry student's prior exposure to laboratory apparatus compared to those not so exposed?

Research question two

How would the academic achievement of student's prior exposed to laboratory apparatus on acquisition of process skills of chemistry differ from those not so exposed?

Research question three

What is the difference in the retention ability of chemistry students prior exposed to laboratory apparatus on acquisition of process skills compared to those not so exposed?

Research question four

What is the difference in the academic achievement of boys and girls when exposed to prior exposure of laboratory apparatus on acquisition of process skills compared to those not exposed?

Hypothesis One:

There is no significant difference between the mean performances of chemistry students prior exposed to laboratory apparatus on acquisition of process skills compared to their counterpart not prior exposed, t-test statistics was used in testing this hypothesis, at $p < 0.05$

Hypothesis Two:

There is no significant difference between the acquisitions of process skills of chemistry students prior exposed to laboratory apparatus compared to their counterpart not prior exposed. t-test statistics was used in testing this hypothesis, at $p < 0.05$

Hypothesis Three:

There is no significant difference between the retention ability of chemistry students prior exposed to laboratory apparatus on Acquisition of process skills compared to their counterpart not prior exposed, t-test statistics was used in testing this hypothesis, at $p < 0.05$

Hypothesis Four:

There is no significant difference between the academic performance and retention of boys and girls prior exposed to laboratory apparatus on acquisition of process skills compared to their counterpart not prior exposed, t-test statistics was used in testing this hypothesis, at $p < 0.05$

CHAPTER FOUR

ANALYSIS, RESULTS AND DISCUSSION

4.1 Introduction

This study investigated the impact of Prior Exposure to Laboratory Apparatus on Acquisition of Science Process Skills, Academic Achievement and Retention in Chemistry among Secondary School Students in Giwa Educational Zone. This chapter is presented under the following sub-heading :

- Data Analysis and Hypothesis Testing
- Results Presentation
- Summary of Findings
- Discussion

4.2 Data Analysis/Hypothesis Testing

The data were collected using Science Process Skill Acquisition Test (SPSAT) and Chemistry Achievement Test (CAT). The data collected were analysed based on the research questions and the hypotheses formulated as follows:

Research Question 1: What is the difference in the mean academic achievement of secondary school chemistry students prior exposure to laboratory apparatus compared to those not prior exposed?

The data collected for the purpose of answering research question one was analysed using descriptive statistics of means and standard deviations as shown in Table 4.1a.

Table 4.1 a: Result of Mean and Standard Deviation Scores of Experimental Group and Control Group.

Variable	N	$\overline{X}$	Sd	MnDf
Exp gp	60	9.46	4.98	
				-0.52
Ctrol gp	60	9.98	4.99	

From Table 4.1 a the result reveals that there is no difference in the mean academic achievement of secondary school chemistry students prior exposure to laboratory apparatus (9.46) compared to those not prior exposed (9.98). Which mean the academic achievement of experimental group is lower than the control group in the beginning in prior exposure to lab apparatus

To test whether there was a significant difference in the mean scores of the experimental and the control groups as stated in HO-i as follows:

Hypothesis One (HO_1): There is no significant difference between the mean academic achievement of secondary school Chemistry Students prior exposed to laboratory apparatus compared to their counterpart not exposed.

The hypothesis one was analysed using t-test statistic at $p< 0.05$. Summary of the result is presented in Table 4.1

Table 4.1 b: Summary of t-test Analysis of Process Skills Acquisition Mean Academic Achievement Scores of Experimental Groups and Control Groups .

Variable	N	$\overline{X}$	Sd	SE	Df	t-val	P	R
Exp gp	60	9.46	4.98	0.64				
					118	0.53	0.00	NS
Ctrol gp	60	9.98	4.99	0.64				

- Significant at $P \leq 0.05$

Table 4.1b indicate the t-value of 0.53 with a p-value of 0.00 and the df of 118. The p-value is less than the stated level of significance set at $p< 0.05$, which is an indication that, there is no significant difference in the academic achievement of student prior exposure to laboratory apparatus i.e. experimental group and those exposed to lecture method at the beginning or initial stage with any prior exposure. Thus, the null hypothesis which states that there is no significant difference between the mean academic achievement of secondary school chemistry students prior exposure to laboratory apparatus compared to their counterpart not exposed was accepted

Research Question: How would the academic achievement of students prior exposed to laboratory apparatus on acquisition of process skills of chemistry differ from those not so exposed?

For the purpose of answering the research question two, the data collected was analysed using descriptive statistics in the form of mean and standard deviation as follows.

Table 4.2a: Summary of Post-Test Means, Mean Difference and Standard Deviations Scores of Experimental Group and Control Group .

Variable	N	$\overline{X}$	Sd	MnDf
Exp gp	60	18.30	7.37	
				5.29
Ctrol gp	60	13.01	5.39	

From the post test score in Table 4.2a which shows that the mean academic achievement of experimental group (18.30) is slightly higher than the control group (13.01) with a mean difference of 5.29 in prior exposure to laboratory apparatus on acquisition of process skill.

To test whether there was a significant difference in the mean scores of experimental and control groups as stated in HC>2 as follows.

Hypothesis Two (H_02): There is no significant difference between the mean academic achievement of secondary school Chemistry Students prior exposed to laboratory apparatus compared to their counterpart not exposed.

To test this hypothesis, data collected were analysed using t-test statistic at $p< 0.05$.summary of the result is presented in Table 4.2b.

Table 4.2b: Summary of t-test Analysis of Post-Test Mean Scores of Experimental Group and Control Group .

Variable	N	$\overline{X}$	Sd	SE	Df	t-val	P	R
Exp gp	60	18.30	7.37	0.95				
					118	4.39	0.00	S
Ctrol gp	60	13.01	5.39	0.69				

- Significant at P <0.05

From Table 4.2b, The result showed t-value of 4.39 with p-value of 0.00 which less than p=0.05 at df =118. The result shows that there is a significant difference in the academic achievement of secondary school chemistry students prior exposed to laboratory apparatus compared with those not so exposed. The significant is in favor of experimental group as shown in their mean scores. Therefore, the null hypothesis which says there is no significant difference in the academic achievements of experimental and control group is thus rejected.

Research Question 3: Does the academic achievement of students prior exposure to laboratory apparatus on acquisition of science process skills of chemistry differ from those not so exposed?

The data collected for the purpose of answering research question three was analysed using means and standard deviations as follows:

Table 4.3a: Summary of Mean, Mean difference and Standard Deviation Scores of Process Skills Acquisition of Experimental Groups and Control Groups .

Variable	N	$\overline{X}$	Sd	MnDf
Exp gp	60	18.37	4.71	
				5.64
Ctrol gp	60	12.73	4.59	

Table 4.3a means standard deviation was calculated for the two groups. The result is presented in table 4.3a which shows that the mean of students prior

exposure to laboratory apparatus is acquisition of science process skill of chemistry (18. 37) is slightly higher than those not so exposed i.e. control group (12.73) with a mean difference of 5.64 in prior exposure to laboratory apparatus.

To test whether there was significant difference in the mean scores of the experimental and control groups as stated in HOs as follows.

Hypothesis Three (Hos): There is no significant difference between the science process skills acquisitions of secondary school chemistry students prior exposed to laboratory apparatus compared to their counterparts not prior exposed.

To test this hypothesis, data collected were analyzed using t-test statistic at $p<0.05$. summary of result is presented in Table 4.3b.

Table 4.3b: Summary of t-test Analysis of Process Skills Acquisition Mean Scores of Experimental Groups and Control Groups .

Variable	N	$\overline{X}$	Sd	SE	Df	t-val	P	R
Exp gp	60	18.37	4.71	0.60	118	6.64	0.00	S
Ctrol gp	60	12.73	4.59	0.51				

- Significant at $P <0.05$

From Table 4.3b,the result shows the t- value calculated of 6.64 at df=118,p-value of 0.00 recorded was less than p=0.05 meaning that there is significant difference in the mean scores of science process skills acquisition of experimental group as shown in the above table. Hence there is significant difference in favour of the experimental group as recorded in their scores. The null hypothesis which says there is no significant difference between the science process skills acquisitions of secondary school chemistry students prior expose to laboratory apparatus compared to their counterpart not prior exposed is rejected.

Research Question 4: What is the difference in the retention ability of chemistry students prior exposure to laboratory apparatus on acquisition of process skills compared to those not so exposed.?

For the purpose of answering research question four, the data collected was analysed using descriptive statistics in the form of mean and standard deviation as follows.

Table 4.4a: Summary t-test Analysis of Mean, Mean difference and standard deviation Score of Experimental Group and Control Group.

Variable	N	$\overline{X}$	Sd	MnDf
Expgp	60	24.30	2.43	
				9.40
Ctrol gp	60	14.90	2.31	

The mean score result shows a high difference in retention ability of those prior exposed to laboratory apparatus on acquisition of process skills compared to those not prior exposed.

To test whether there was a significant difference in the mean scores of the experimental and control groups as stated in HO_4 as follows:

Hypothesis Four (H_04): There is no significant difference between the retention of secondary school chemistry students prior exposed to laboratory apparatus compared to those not exposed.

To test this hypothesis, data collected were analyzed using t-test statistic at $p<0.05$. Summary of the result is presented in Table 4.4b

Table 4.4b: Summary of t-test Analysis of retention Ability of Experimental Group and Control Group.

Variable	N	$\overline{X}$	Sd	SE	Df	t-val	P	R
Exp gp	60	24.30	2.43	0.31				
					118	8.27	0.00	S
Ctrol gp	60	14.90	2.31	0.29				

- Significant at $P <0.05$

From Table 4.4, the result shows the t-cal of 18.27, at df=118,p-value of 0.00 recorded is less than p=0.05, meaning that there is significant difference in the mean score retention ability of secondary school chemistry students prior exposed to laboratory apparatus i.e experimental group compared to the control group not prior exposed is rejected.

Research Question 5: Is there any difference in the academic achievement of boys and girls when exposed to prior laboratory apparatus on acquisition of process skills compared to those not exposed.?

For the purpose of answering research question five,the data collected was analysed using descriptive statistics in the form of mean and standard deviation as follows.

Table 4.5a: Summary of Mean, Mean difference and Standard deviation Score on Academic Achievement of Boys in Experimental Group and Control Group .

Variable	N	$\overline{X}$	Sd	MnDf
Expgp	31	9.37	2.36	
				3.01
Ctrol gp	29	6.36	2.28	

To answer this research question, mean and standard deviation was calculated for the two groups. The result is presented in Table 4.5a which indicates that the mean academic achievement of the male experimental group (9.37) is slightly higher than the male control group (6.36) with a mean difference of 3.01 in prior exposure to laboratory apparatus.

To test whether there was a significant difference in the mean scores of the experimental and control groups as stated in HO_5 as follows.

Hypothesis Five (HO_5): There is no significant difference between the mean academic achievement of boys Chemistry Students prior exposure to laboratory apparatus compared to their counterpart not exposed.

To test this hypothesis, data collected were analyzed using t-test statistic at p< 0.05.summary of the result is presented in Table 4.5b.

Table 4.5b: Summary of t-test Analysis of Mean Score of Academic Achievement of Boys in Experimental and Control Group .

Variable	N	$\overline{X}$	Sd	SE	Df	t-val	P	R
Exp gp	31	9.37	2.36	0.31				
					59	3.32	0.01	S
Ctrol gp	29	6.36	2.28	0.29				

- Significant at $P <0.05$

The result in Table 4.5b. reveals, the t- value of 3.32 with a p- value of 0.01 and df of 59. The p- value is less than the stated level of significance set at p=0.05. which infers that there is a significant difference in the mean achievement of boys that are prior exposure to laboratory apparatus than tthose that are not prior exposed. Thus the null hypothesis which says there is no significant difference between the achievement of boys chemistry students prior exposure to laboratory apparatus compared to their counterpart not prior exposed was rejected.

Hypothesis HO_C: There is no significant difference between the mean achievement of girls chemistry students prior exposed to laboratory apparatus and their counterpart not prior exposed.

To test this hypothesis data collected were analyzed using t-test statistic at $P < 0.05$

Table 4.5c: summary t-test analysis of mean score of academic achievement of girls prior exposed to laboratory apparatus and those not prior exposed to laboratory apparatus.

Variable	N	$\overline{X}$	Sd	SE	Df	t-val	P	R
Exp gp	29	9.36	2.34	0.30				
					59	3.22	0.01	S
Ctrol gp	31	6.37	2.22	0.28				

- Significant at $P < 0.05$

From Table 4.5c, the result shows that t-value of 3.22, with p-value of 0.011 and df of 59. The p-value is less than the stated level of significance set at p=0.05. which infers that there is significant difference in the mean achievement of girls prior exposure to laboratory apparatus than those not prior exposed. Thus the null hypothesis that says there is no significant difference between the mean achievement of girls chemistry students prior exposure to laboratory apparatus compared to their counterpart not prior exposed was rejected.

Hypothesis Six (HO_6): There is no significant difference between the academic achievement of boys and girls chemistry students prior exposed to laboratory apparatus and their counterparts not prior exposed.

To test this hypothesis the data collected from the two groups were analyzed using t-test statistic at $P < 0.05$

Table 4.6: Summary t-test analysis of mean score of Boys experimental group and girls experimental groups.

Variable	N	$\bar{X}$	Sd	Sd^2	Df	t-val	P	R
Exp gp	31	6.90	7.20	50.84	58	0.59	0.021	NS
Ctrol gp	29	6.69	7.16	50.27				

- Not significant at $P < 0.05$

The result in Table 4.6, indicates the t-value of 0.59 with the p-value of 0.021 which is less than p-value of 0.05 and the df of 58. The result shows that t-value of 0.59 was observed. Which infers that there is a significant difference in the achievement of male and female in experimental group. Thus the null hypothesis that says there is no significant difference between the academic achievement of boys and girls chemistry students prior exposed to laboratory apparatus and their counterpart not prior exposed way reflected. Thus show that prior exposure to laboratory apparatus of boys and girls chemistry students is gender

4.3 Summary of Findings

Based on the four hypotheses tested in this study, the results of the study are summarized as thus:

1. There is no significant difference in the mean score achievement of students in experimental group prior expose to laboratory apparatus on acquisition of process skills than control group not prior exposed. Hypothesis 1 is retained.
2. There is significant difference in the mean score achievement of experimental group after prior expose to laboratory apparatus on acquisition of science process skills and control group not prior exposed. Hypothsis2 is in favour of experimental group.
3. There is significant difference in the retention ability of experimental group after prior expose to laboratory apparatus on acquisition of science process skills and control group not prior exposed. Hypothesis 3 is therefore in favour of experimental group.
4. There is significant difference in the acquisition of science process skills of boys in the experimental group who are prior exposed to laboratory apparatus than boys in control group not prior exposed. Hypothesis4 is therefore in favour of experimental group.
5. There is significant difference in the acquisition of science process skills of girls in the experimental group who are prior exposed to laboratory apparatus than those in control group not prior exposed. Hypothesis 4 is therefore in favour of experimental group.
6. There is no difference in the acquisition of science process skills of boys and girls in the experimental group who are both prior exposed to laboratory apparatus. Hypothesis4 is therefore favoured.

4.4 Discussion

Based on the Chemistry Achievement Test (CAT) and the Responses to the Science Process Skills Acquisition Test (SPSAT), the data generated for this study were subjected to Statistical analysis, the analysis addressed the research questions, formulated hypothesis and the findings of the results are discussed as follows:

The result from Table 4.1b reveals that there is a no significant difference in the mean scores of the experimental and control groups at the beginning or initial stage of this study without any prior exposure to laboratory apparatus on acquisition of science process skills. This finding thus establishes that there is no impact of the model on acquisition process skill approach (Strategy) employed to teach the concepts and academic achievement in chemistry.

The result from Table 4.2b however reveals that there is a significant difference in the academic achievement of secondary school chemistry students Prior exposed to Laboratory apparatus i.e experimental group compared to those not priorly exposed. This finding thus establishes that there is a significant difference between prior exposure to laboratory apparatus on acquisition of science process skills strategy employed to teach concepts and academic achievement in chemistry. It also goes to show that, prior exposure to laboratory apparatus on acquisition of science process skills strategy was very effective in enhancing academic achievement in chemistry.

The findings of this study is inline with those of some past studies which were of the view that, for concepts to be taught in sciences properly for learners to understood, the method used in teaching the concepts plays a vital role. Such studies include those by Hodson (2006) who stated that prior exposure to laboratory apparatus on acquisition of Science process skills goes beyond mere seeing which appear more than simply holding a piece of apparatus. He says that the Raw sense behind being exposed to laboratory apparatus can be 'seen' almost unconsciously, without having any significance attached to them. However, when this 'seeing' is registered and interpreted in the light of prior exposure and expectation, it becomes acquisition of science process skills.

This emphasizes the importance of having prior exposure to laboratory apparatus before setting out to a chemical concepts in chemistry and this clearly calls for prior exposure to laboratory apparatus on acquisition of science process skills strategy. Kuiper (2002), Kerr (2003), Rebecca (2001),Sariba and Hale (2009) had affirmed that, their findings, suggest that good learners engage in prior exposure to laboratory apparatus on acquisition of science process skills, will enhance the quality of their work and get them involved in acquisition of science process skills and management of their thoughts.

Results from this study are in consonance with the earlier observations of Pajeres and Miller (1994), and Mari (1994) and Zimmerman (2000) which observed that learning acquisition of science process skills enhances learning behaviour which in turn ensure motivation and confidence as a learner engage in learning tasks and solving of problems in chemistry.

However the results of this study are contrary to the finding of Olagunju (2001) that shows no significant difference in chemistry achievement reported in this study.

Results from Table 4.3b revealed that prior exposure to laboratory apparatus can impact acquisition of science process skills on students positively, as subjects in the experimental groups are observed to have develop more confidence in observing, manipulating skills after experiencing the treatment. This result buttresses those of previous studies by some scholars such as Mari (1994), Ajemole (2005),Sani (2007),Rebecca(2001),Kerr(2003),AI-Shuaili(2009) Johnstone(2009),and Hodson(2006). They had revealed that prior exposure to laboratory apparatus plays a major role in students learning and acquiring of science process skills and that the teaching strategy, if employed by science teacher could aid students toward developing confidence in the learning of chemical concepts in chemistry.

In a study, usman and memeh (2007) investigated the factors that negatively affect chemistry achievement to includes students back ground problems, teacher related factors like poor teacher preparation, inadequate instructional materials and above all application of poor teaching methods. The results showed that achievement in chemistry at the secondary school remain low and unimpressive, because chemistry teachers mainly adopt instructional strategies that are mainly teacher directed and do not encourage deeper students involvement and self regulation. Simon and Zimmerman (1990) are of the view that learners should possess relevant skills which enhance their ability to construct knowledge, assume responsibility for their own learning and realize that learning is a personal experience that requires active and dedicated participation. So prior exposure to laboratory apparatus strategy helps to locate understanding within the learners. This therefore makes learners to take responsibility for their learning.

The results as presented in Table 4.4b reveals that there was a high significant difference to the retention ability of chemistry students taught using prior exposure to laboratory apparatus strategy compared with those not prior exposed. Literatures on past studies by some scholars on retention ability of students are difficult to come by and result of the study by Ikedolapo and Adetunji (2009) on retention ability of concepts and genders, revealed that there was no significant difference in the mean academic achievement of the subjects due to post posttest (retention) treatment. But the results of this study shows a contrary view and this is inline with sereval studies that were carried out on students retention ability in chemistry. Erikson (2005) found that laboratory apparatus skills aids the cognitive levels of students with high retention ability. Study of Krulik (2010) reveal that regular instruction on prior exposure resulted in more retentive learning than those without. Abah(2003)study shows that , Nigeria secondary school where chemistry teachers made appropriate use of laboratory apparatus, students obtained higher academic achievement and retention ability in chemistry scores at senior secondary school level. The study by Kwon, Allen and Rasmuseen (2005) that investigated students retention ability of mathematical knowledge and skills in two differential equation classes. The results showed that students exposed to inquiry - oriented classes retained conceptual knowledge that lead to their longer retention ability of mathematical knowledge than those taught traditionally.

The study by Achor, Imoko and Uloko (2009) determined the effectiveness of ethnomathematics teaching approach (ETA) on students achievement and retention ability. It revealed that students exposed to ETA were superior in achievement and rete than those taught with conventional method. This is inline with the result of this study that reveal also the superiority of prior exposure to laboratory apparatus on acquisition of science process skills.

The results from this study as presented in Table 4.5b and 4.5c reveals that, there were no significant difference in the academic achievement and retention ability of the experimental group i.e (boys & girls). This shows that gender is not a significant factor in the students chemistry achievement and retention ability.The findings contradicts some earlier studies, for instance Momoh (2001), Usman and Ubah (2007) who observed a significant difference in chemistry achievement based on gender. However, the findings of the study of Olarewaju(2004) reported no significant differences between boys and girls achievement and retention ability in the knowledge of biology concepts. The study of Dahiru(2004) also revealed that there is no significant difference between gender relationship and selection of science subject in the area he conducted his research as reported in this study. The prior exposure to laboratory apparatus on acquisition of science process skills approach by both boys and girls in the experimental group could have removed gender related disadvantage in chemistry learning

The results from this study as presented in Table 4.6 reveals that, there were no significant difference in the academic achievement and retention ability of the experimental group i.e (boys & girls). This shows that gender is not a significant factor in the students chemistry achievement and retention ability. The findings contradicts some earlier studies, for instance Momoh (2001), Usman and Ubah (2007) who observed a significant difference in chemistry achievement based on gender. This prior exposure to laboratory apparatus on acquisition of science process skills encourage confidence, self regulated learning and could have motivated both gender to actively participated in chemistry learning process. The findings of the study showed that the impact of prior exposure to laboratory apparatus on acquisition of science process skills indicates that both gender benefited almost equally from the prior exposure to laboratory apparatus on acquisition of science process skills approach.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

In this chapter, an attempt was made to explain the followings:

- Summary
- Major Findings
- Conclusions
- Recommendations
- Limitation of the Study
- Suggestions for Further Studies

5.2 Summary

The researcher made an attempt in this study to find out the influence of prior exposure of laboratory apparatus on acquisition of science process skills, academic achievement and retention in chemistry among senior secondary school students in Giwa educational zone. The study made use of 120 science students from two government secondary schools, government secondary school Bomo and Dr. Yusuf Aboki secondary school Shika. They were divided into two groups of 60 students each. 60 students were used for the experimental group and 60 students for the control group. Chemistry Achievement Test (CAT) and Acquisition of Science Process Skills Test (SPSAT) designed by the researcher were given to the students and the scores obtained were used for assessment of the subjects academic achievement and Retention in Acquisition of Science Process Skills in Chemistry concepts to which they were prior exposed to laboratory apparatus. The data collected for the study were analysed using mean, standard deviation and t-test.

The results obtained show that there were significant differences in achievement, retention and acquisition of science process skills of the two groups with prior exposure and non prior exposure to laboratory apparatus.

5.3 Summary of Major Findings

1. There is no significant difference in the pre-test mean score academic achievement of students in experimental group before prior expose to laboratory apparatus on acquisition of process skills and control group not prior exposed.
2. There is significant difference in the mean score academic achievement in favour experimental group i.e. prior expose to laboratory apparatus and control group not prior exposed to laboratory apparatus.
3. 3. There is significant difference in the retention ability in favour of experimental group prior exposed to laboratory apparatus and control group not prior exposed to laboratory apparatus.
4. There is significant difference in the acquisition of science process skills in favour of the experimental group who are prior exposed to laboratory apparatus group who are not prior exposed.
5. There is no significant difference in the mean score academic achievement of boys and girls students in experimental group prior exposed to laboratory apparatus.

5.4 Conclusions

The following conclusions are derived from the study;

The results of the study shows the fact that, the use of prior exposure to laboratory apparatus on acquisition of science process skills enhance and promote effective science learning than science taught without prior exposure to laboratory apparatus. The results did not support the five hypotheses and they were rejected. It was found that the experimental group was significantly better than the control group. Their academic achievement, retention and acquisition of science process skills in the science concept were employed in the study; which shows significant difference in their cognitive achievement, retention and science process skills in chemistry within prior exposure and non prior exposure to laboratory apparatus. From the findings of the study therefore, it was concluded that the influence of prior exposure of laboratory apparatus on acquisition of science process skills among secondary school chemistry students have significant influence on their academic achievement retention and acquisition of science process skills in the learning of chemistry in secondary schools.

5.5 Contribution to Knowledge

The development of Science Process Skills Acquisition Test (SPSAT) instrument for senior secondary school by the researcher is a contribution to knowledge.

All other studies in chemistry at secondary school level (SS) wERE done on teaching method, attitude, use of instructional materials. But studies on prior exposure of secondary school chemistry students to laboratory apparatus is major contribution and was found to enhance secondary school chemistry students academic achievement and retention ability.

5.6 Recommendations

Based on the findings of this study, the following recommendations were made:

1. Curriculum planner should recommend the use of prior exposure to laboratory apparatus on acquisition of science process skills approach in the teaching and learning of chemical concepts. This is because, this approach has the method for creating friendly activities that make the learning of the topics like volumetric analysis and separation techniques more meaningful.
2. Conferences, Seminars and workshop should be organized by Professional Associations and Educational research centers to sensitize the various stake holders on the need for the adaptation of the prior exposure to laboratory apparatus on acquisition of science process skills in our secondary schools.
3. Science curriculum developers, supervisory bodies of secondary schools and Teachers should popularize and incorporate prior exposure to laboratory apparatus on acquisition of science process skills approach into the curricula of all secondary schools.

4. Science curriculum developers and Educators should produce textbooks and teacher guides based on prior exposure to laboratory apparatus model of teaching and learning strategy.
5. Examination bodies should introduce prior exposure to laboratory apparatus question model in their examination syllabuses and question papers.
6. Teachers teaching at secondary schools level should be trained and retrained through workshops on the use of prior exposure to laboratory apparatus in the teaching chemical concepts.

5.7 Limitation of the Study

The study is limited to the senior secondary schools class in Giwa Educational Zone. SS II students were chosen for the study due to the fact that SS I are just newly introduced into chemistry, while the SS III students would have been planning to write their SSCE. The researcher could not extend the study to all the secondary schools in Giwa educational zone as intended due to:

i distance and time factor as well as the geographical spread of the schools in the area .

ii Insufficient laboratory apparatus in most of the secondary schools around.

iii Lack of reagent needed for the preparation of gases or solutions for the study,

iv The scope of science process skills to be selected for this study is limited to the basic science skills. These are: observation, hypothesis, classification, measurement, manipulation experimentation and inference.

5.8 Suggestions for Further Studies

This study may be exposed further on the following ways;

1. Similar studies on other science subjects may be carried out to see if prior exposure to laboratory may facilitate student's achievement.
2. Since the study was carried out using secondary school students, similar studies may be carried out using higher institutions of learning.

3. There is need to further investigate the impact of prior exposure to laboratory apparatus using other scientific activity of teaching among others.

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Appendix A
Chemistry Achievement Test
Choose from the options lettered A to D

1. Which of the following physical property cannot be used as the basis for the separation of mixtures.
a. Physical state
b. Particle size
c. Smell
d. Magnetic property
2. Which of the following is a separation technique used in the separation of a solid from a liquid?
a. Sublimation
b. Floatation
c. Evaporation
d. Simple distillation
3. The filtration technique is based on the differences in the physical state and the____________of one component of the mixture in the other.
a. Solubility
b. Insolubility
c. Boiling point
d. Melting point
4. Crystals of sugar are obtained from sugar solution by_________
a. Fractional crystallization
b. Precipitation
c. Sublimation
d. Crystallization
5. Common salt {sodium chloride} and green vitriol {Iron (II) sulphate} are both soluble in water. An equal volume of ethanol is added to the solution. The green vitriol is insoluble in ethanol. What separation techniques should be used?
a. Physical precipitation
b. Chemical precipitation
c. Dissolution
d. Fractional distillation
6. All of the following are methods of separating mixtures of solids except__________
a. Sublimation
b. Separating funnel
c. Magnetization
d. Floatation
7. The pure solid obtained when the vapour of a substance which sublimes solidifies is called a___________
a. Filtrate
b. Sublimation
c. Sublimate
d. Sublimed product

8. Which of the following chemical substances does not sublime?
a. Solid carbon(iv)oxide
b. Iodine
c. Ammonia chloride
d. Turpentine
9. What is the trend you will follow to separate a mixture of Ammonia chloride, Iron fillings and sodium chloride.
a. Evaporation, magnetization,
b. magnetization, sublimation
c. magnetization, evaporation
d. Sublimation, magnetization
10. __________ is a separation method that can be used to separate a mixture of ethanol with a boiling point of 100°C.
a. Use of separating funnel
b. Precipitation
c. Simple distillation
d. Fractional distillation
11. The separating funnel is used to separate
a. A mixture of a polar and a non-polar solvent
b. Two miscible liquids
c. A solvent from a saturated solution
d. A mixture
12. Miscible liquids with close boiling point can be separated using________
a. Distillation
b. Simple distillation
c. Fractional distillation
d. separating funnel
13. All the apparatus listed below are used in fractional distillation. Identify the apparatus that is important and unique for this technique
a. Liebig condenser
b. Fractionating column
c. Thermometer
d. Round bottom flask
14.. Which of the following methods can be used tp separate a mixture of methyl orange and phenolphthalein
a. Decantation
b. Distillation
c. Chromatography
d. Evaporation
15. Which of the following apparatus is not required in volumetric analysis
a. Standard flask
b. Bunsen burner
c. Filter funnel
d. Burette
16. The unit of the molar mass of a chemical substance is

a. $gmol^{-1}$

b. g/mol^{-1}
c. gmole
d. 9
17. A primary standard is anhydrous, non-hygroscopic, solution in water and
a. Deliquescent
b. Non-deliquescent
c. Hygroscopic
d. Efflorescent
18. A standard solution of mineral acids, alkalis and salts cannot be prepared because of__________
a. Some of them are anhydrous
b. Some of them are non-hygroscopic
c. They are heavy
d. Some of them are corrosive and volatile liquids.
19. When a substance is not available in a pure state, a process of _________is used to obtain its standard solution.
a. Titration
b. Neutralization
c. Precipitation
d. Reaction
20. Calculate the mass of hydrated ethanedioc acid, $H2C2O_4 2H_2O$ needed to prepare $5.0dm^3$ of a $0.105moldm''^3$ solution.
$[H_2C_2 04.2H20 = 126gmo1^{-1}]$
a. 0.525g
b. 66.2g
c. 6.62g
d. 5.25g
21. If 14.16g of Barium Chloride were dissolved in $200cm^3$ of water, calculate the concentration of the resulting solution in $moldm''^3$. $[BaCI_2 = 208gmol^{-1}]$
a. $O.IOOmoldm^{-3}$
b. $0.01\ moldm^{-3}$
c. $0.001\ moldm^{-3}$
d. $0.0001\ moldm^{-3}$
22. If $20cm^3$ of distilled water is added to $20cm^3$ of an aqueous salt solution, the concentration of the solution
a. Increases
b. Decreases
c. Remains constant
d. Doubles
23. In an acid - base titration, a sudden change in the colour of the indicator signals the____________
a. Neutralization
b. Dilution point
c. End point
d. Saturation

24. Burette readings___________
a. Decreases downward
b. Increases downward
c. Increase upward
d. None of the above
25. Indicators are used in acid - base titration for all of the following except
a. To detect the endpoint of the reaction
b. To test for the acidity of the solution
c. To test for the alkalinity of the solution
d. To test for colour change
26. A wrong choice of indicator usually leads to a__________
a. Wrong dilution point
b. Wrong saturation point
c. Wrong Endpoint
d. Strong Acid production
27. Which of the following precaution during titration is wrong?
a. Rinse the pipette with acid
b. Shake the conical flask during titration
c. Pipette to the mark: to avoid using more or less solution than required.
d. Remove air bubbles from the burette or pipette to obtain accurate volume of solution.
28. What is the colour of methyl orange in alkalis?
a. Pink
b. Orange
c. Yellow
d. Red
29. What is the colour of methyl red in acid?
a. Yellow
b. pink
c. Red
d. Orange
30. The colour of phenolphthalein at the end point is__________
a. Pink
b. Purple
c. Yellow
d. Colourless
31. Which of the following set of Titre values is consistent?
a. $21.40cm^3$, $21.35cm^3$
b. $21.65cm^3$, $21.10cm^3$
c. $35.00cm^3$, $36.00cm^3$
d. $22.40cm^3$, $21.40cm^3$
32. What volume in cm^3 of $0.50moldm^{-3}$ H_2SO_4 will exactly neutralize $20cm^3$ of G.lmoldm^{-3} NaOH solution?
a, 1.0
b. 2.0

c. 4.0
d. 6.0
e. 8.0

33. A suitable indicator for the titration of ethanedioc acid and potassium oxide is__________
a. Phenolphthalein
b. Methyl orange
c. Methyl Red
d. Litmus solution

34. At the end point of an Acid - base titration, the amount of acid used is directly proportional to the coefficient of the acid in the balanced equation of reaction. This is represented as___________
a. C_BV_B a DB
b. C_AV_Aa1/n_A
c. C_BV_B a 1/n_B
d. C_AV_A a H_A

A is 0.125 moldnrf^3 H_2SO_4
B contains Y gdm"^{3} of KOH
In an acid - base titration, 25.0cm^3 of B requires an average of 21.60cm^3 of A for complete neutralization.
$H_2SO_{4(aq)}$ + 2KOH -----> $K_2SO_{4(aq)}$ + $2H_2O_{(l)}$

35. Calculate the amount of H_2SC>4 in the average volume of acid used.
a. 0.00270 mol
b. 2.700 mol
c. 0.0270 mol
d. 0.270 mol

36. Calculate the concentration of B in molm"^{3}
a. 0.00540 moldm'^{3}
b. 0.0540 moldm'^{3}
c. 0.216 moldm"^{3}
d. 0.0216 moldm'^{3}

37. Calculate the value of Y
a. 1.21gdm"^{3}
b. 12.1gdnT^3
c. 12.1 moldm"^{3}
d. 12.1

38. Calculate the mass of salt formed when 500cm^3 of B is completely neutralized by A
a. 9396g
b. 9.40g
c. 9396
d. 9.40

39. There are two indicators that are not used in a redox titration and one of them is

a. Methyl orange
b. Litmus paper
c. Starch solution
d. Methyl red

APPENDIX B

SCIENCE PROCESS SKILLS ACQUISITION TEST ON CHEMISTRY

Instruction: Please attempt all questions, ail answers must be written on the question paper. Do not starts until you are ask to do so.

Fill in the blank spaces with the correct answers

1. Mixtures are separated in order to remove_________and hence obtain pure samples of chemical substances.
2. __________is a separation technique used to separate a mixture of solid that is insoluble in water
3. During filtration, the solid left on the filter paper is called_________while the liquid in the receiver (beaker) is called___________
4. A mixture of iron nails and water can be separated using__________as a separation technique.
5. Solid X in a solution A has a high melting point__________is a method of separation that can be used to recover solid X from the solution.
6. When the crystallization process is repeated on a given solid sample using a fresh solvent, it is called __________ and this is done to obtain _________crystals.
7 The separation technique used in the hospital laboratory to separate the blood cells from plasma is called___________
8. __________is the most important similar laboratory apparatus used in simple distillation and fractional distillation.
9. The crystals obtained from crystallization are___________than those obtained from evaporation.
10. __________ is a type of chromatography used for the separation of complex gases mixtures.
11. Paper chromatography is also known as__________chromatography,
12. In paper, chromatography, a strip of filter paper used as the stationary process is known as the____________medium
13. The paper used in paper chromatography is called a________________
14. __________is used as an adsorbent in column chromatography.
15. __________is an apparatus used to transfer a specific volume of the alkali into the conical flask.
16. The apparatus used to prepare a standard solution to a specific volume in volumetric analysis is known as_______________
17. __________is a solution of known concentration
18. Mass concentration is expressed in___________
19. Molar concentration is expressed in____________
20. ____________is a substance that can be obtained in a high state of purity
21. __________is the reaction between an acid and a base to produce a salt and water only.
22. Redox titration involve reactions between___________and___________ agents
23. In column chromatography, a glass tube is used as the___________

APENDIX C
MARKING SCHEME OF CHEMISTRY ACHIEVEMENT

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

APPENDIX D
MARKING SCHEME OF SCIENCE PROCESS ACQUISITION SKILLS TEST

1	Impurities
2	Filtration
3	Residue, filtration
4	Decantation
5	Evaporation
6	Recrytalization Purer
7	Centrifuging
8	Liebig Condenser
9	Purer
10	Gas Chromatography
11	Thin Layer
12	Adsorben
13	Chromatogram
14	Alumina (Aluminium oxide)
15	Pippette
16	Standard or volumetric flask
17	Standard Solution
18	g/dm-^{3}
19	Mol/drrr^{3}
20	Primary Standard
21	Neutralization
22	Oxidizing and reducing
23	Column
24	Burette and Pipette
25	Methyl orange

APPENDIX E
LABORATORY APPARATUS APPROACH STRATEGY.
MODEL LESSON PLAN ONE.

Subject: Chemistry
Topic: Qualitative Analysis of Laboratory Preparation of Gases
Age: 15/16 years
Duration: 2 Hours
Teaching Aids: Solution of H_2SO_4, dilute HCI, filter paper, Laboratory Apparatus etc.
Behavioral Objective: By the end of the lesson students should be able to

i. Acquire certain level of science process skills which may includes observation, manipulation, measuring, inference interpretation etc.
ii. Identify the gases present from the salt samples provided.

Introduction: The lesson will be introduced to the student with provisions of laboratory apparatus that are required for the experiment, organizing students and resources for effective learning, provision of clear instructions on students activities, managing student task and thinking as well as summering the key concept and ideas which students are required to remember on the black board and reagents on the bench for them to see and observed.
Presentation: The teacher presents the lesson through the following activities.
Activity:

- Provision of laboratory apparatus for the experiment e.g. Beakers, test tube, test tube rake, measuring cylinder, reagent bottle with different solution required, Bunsen burner, filter paper, etc. discuss the function of each laboratory apparatus on the black board.
- Sample of the salt A is a chloride salt
- Sample of the salt B is a solid salt $CaCO_3$.
- Add $1cm^3$ of sample A to a few drop of cone H_2SO_4
- Add $1cm^3$ of Sample B to Cone H_2SO_4.
- Add the mixture of the chloride salt to MnO_2 powder then heat.
- Put a little amount of solid $CaCO_3$ in a test tube then heat.
- State your observation in each case
- Use ruler to measure the height of the solution.
- Use litmus paper to note any colour change
- Dip a glass capillary tube into a clean lime water and insert it into the tube of the gas.

Conclusion

Prior exposure to laboratory apparatus approach is a scientific and well integrated way of teaching difficult concept in chemistry during which students are encourage to develop their science process skills acquisition in order to explore their environment

LABORATORY APPARATUS APPROACH STRATEGY.
MODEL LESSON PLAN TWO.

Subject: Chemistry
Topic: Qualitative Analysis of Laboratory Preparation of Gases
Age: 15/16 years
Duration: 2 Hours
Teaching Aids: Solution of $CaCO_3$, $NaHCO_3$, dilute HCI, filter paper, Laboratory Apparatus etc.
Behavioral Objective: By the end of the lesson students should be able to

i. Acquire certain level of science process skills which may includes observation, manipulation, measuring, inference interpretation etc.
ii. Identify the gases present from the salt samples provided.

Introduction: The lesson will be introduced to the student with provisions of laboratory apparatus that are required for the experiment, organizing students and resources for effective learning provision of clear instructions on students activities, managing student, task and thinking as well as simmering the key concept and ideas which students are required to remember on the black board and reagents on the bench for them to see and observed.
Presentation: The teacher presents the lesson through the following activities.
Activity:

- Provision of laboratory apparatus for the experiment eg Beakers, test tube, test tube rake, measuring cylinder, reagent bottle, washing bottle, different solution required, Bunsen burner, filter paper, for students to observe and discuss the function of each one on the black board.
- Add dilute hydrochloric acid to a small quantity of each of the following substances.

A. Calcium trioxocarbonate (iv) $CaCO_3$ or sodium hydrogen trioxocarbonate (iv) $NaHCO_3$
B. Sodium trioxosulphate (iv) Na_2SO_3

- Use the same procedure as lesson one to carry the activity for the experiment.

Conclusion

Prior exposure to laboratory apparatus approach is a scientific and well integrated way of teaching difficult concept in chemistry during which students are encourage to develop their science process skills acquisition in order to explore their environment.

LABORATORY APPARATUS APPROACH STRATEGY.
MODEL LESSON PLAN THREE.

Subject: Chemistry
Topic: Separation Techniques (Filtration)
Age: 15/16 years
Duration: 2 Hours
Teaching Aids: Beakers, stirring rod, filter paper. and other etc
Behavioral Objective: By the end of the lesson students should be able to

i. Acquire certain level of science process skills which may includes observation, manipulation, measuring, inference interpretation etc.
ii. Identify the cleared filtered solution at the end of the reaction.

Introduction: The lesson will be introduced to the student with provisions of laboratory apparatus that are required for the experiment, organizing students and resources for effective learning provision of clear instructions on students activities, managing student, task and thinking as well as simmering the key concept and ideas which students are required to remember on the black board and the solution for them to see and observed.

Presentation: The teacher will present the lesson through the following activities.

Activity:

- Provision of laboratory apparatus for the experiment and priory exposed to the students eg retort stand, stirring rod, beakers, funnels, filter paper etc. for students to describe their function and procedure of carrying out the experiment and each written on the board after each explanation by the students.
- Add water to chalk dust to become a suspension
- Pour out the suspension into a filter paper
- Allow the water poured or filter paper to pass through
- Leave the chalk particle on the filter paper
- Record out your observations.

Conclusion

Prior exposure to laboratory apparatus approach is a scientific and well integrated way of teaching difficult concept in chemistry during which students are encourage to develop their science process skills acquisition in order to explore their environment.

LABORATORY APPARATUS APPROACH STRATEGY.
MODEL LESSON PLAN FOUR.

Subject: Chemistry
Topic: Separation Techniques (Evaporation of a Salt Solution)
Age: 15/16 years
Duration: 2 Hours
Teaching Aids:
Behavioral Objective: By the end of the lesson students should be able to

i. Acquire certain level of science process skills which may includes observation, manipulation, measuring, inference interpretation etc.
ii. Identify the cleared filtered solution at the end of the reaction.

Introduction: The lesson will be introduced to the student with provisions of laboratory apparatus that are required for the experiment, organizing students and resources for effective learning provision of clear instructions on students activities, managing student, task and thinking as well as simmering the key concept and ideas which students are required to remember on the black board and the solution for them to see and observed.

Presentation: The teacher will present the lesson through the following activities.

Activity:

- Provision of laboratory apparatus for the experiment are priory exposed to the students.eg beakers, tripol stand, wire gauze, bunsen burner, petric dish
- Place the solution on the solute or the water bath
- Observed the experiment and record the result of the observation.

Conclusion

Prior exposure to laboratory apparatus approach is a scientific and well integrated way of teaching difficult concept in chemistry during which students are encourage to develop their science process skills acquisition in order to explore their environment.

LABORATORY APPARATUS APPROACH STRATEGY.
MODEL LESSON PLAN FIVE.

Subject: Chemistry
Topic: Volumetric Analysis (Titration)
Age: 15/16 years
Duration: 2 Hours
Teaching Aids: Solution of cone HCI, solution of anhydrous Na2Cos, laboratory Apparatus etc.
Behavioral Objective: By the end of the lesson students should be able to

i. Acquire certain level of science process skills which may includes observation, manipulation, measuring, inference interpretation etc.
ii. Identify the color change present at the end of the reaction.

Introduction: The lesson will be introduced to the student with provisions of laboratory apparatus that are required for the experiment, organizing students and resources for effective learning provision of clear instructions on students activities, managing student, task and thinking as well as simmering the key concept and ideas which students are required to remember on the black board and the solution for them to see and observed.

Presentation: The teacher will present the lesson through the following activities.

Activity:

- Provision of laboratory apparatus for the experiment eg, burette, pipette, measuring cylinder, retort stand, conical flask beakers, funnel volite slide for students to observe and discuss the functions of each
- Pour out the cone HCI into the burette
- Pipette out $25cm^3$ of Na_2Co_3 solution into the conical flask
- Titrate the solution of Cone HCI against solution of anhydrous Na_2Co_3 with two drops of an indicator methyl orange
- Tabulate your titre readings and the color change in first, second and third titration.

Conclusion

Prior exposure to laboratory apparatus approach is a scientific and well integrated way of teaching difficult concept in chemistry during which students are encourage to develop their science process skills acquisition in order to explore their environment.

LABORATORY APPARATUS APPROACH STRATEGY.
MODEL LESSON PLAN SIX.

Subject: Chemistry
Topic: Volumetric Analysis (Titration)
Age: 15/16 years
Duration: 2 Hours
Teaching Aids: Solution of cone HCI, solution of anhydrous Na2Cos, laboratory Apparatus etc.
Behavioral Objective: By the end of the lesson students should be able to

i. Acquire certain level of science process skills which may includes observation, manipulation, measuring, inference interpretation etc.
ii. Identify the color change present at the end of the reaction.

Introduction: The lesson will be introduced to the student with provisions of laboratory apparatus that are required for the experiment, organizing students and resources for effective learning provision of clear instructions on students activities, managing student, task and thinking as well as simmering the key concept and ideas which students are required to remember on the black board and the solution for them to see and observed.

Presentation: The teacher will present the lesson through the following activities.

Activity:

- Provision of laboratory apparatus as above.
- Pipette solution of Cone H_2So_4 in burette
- Pipette $5cm^3$ disolve pellets of NaoH in $1dm^3$ of solution into a conical flask.
- Add drops of methyl orange as indicator.
- Tabulate your titre readings and the color change in first, second and third titration.

Conclusion

Prior exposure to laboratory apparatus approach is a scientific and well integrated way of teaching difficult concept in chemistry during which students are encourage to develop their science process skills acquisition in order to explore their environment.

LECTURE METHOD LESSON PLAN ONE

SUBJECT: CHEMISTRY
TOPIC: Qualitative analysis of Laboratory preparation of gases.
CLASS: SS II Students
AGE: 15-16 years
SEX: Boys/Girls
DURATION: 2 hours
TEACHING AIDS: Gases, CI_2, SO_2, H_2, HCI, HN_3, H_2S, $C0_2$ Solution of H_2S0_4, dilute HCI, filter paper e.t.c
BEHAVIOURAL OBJECTIVE: By the end of the lesson Students should be able to identify gases presented through careful observation of their physical properties (i.e crystalline etc.).
PREVIOUS KNOWLEDGE: Students learnt the concept of acid base and salt.
INTRODUCTION: The teacher introduced the lesson by reviewing briefly the concept of acid, base and salt. The teacher will at this stage of the lesson provide resources for learning, organizing students and resources for effective learning, provision of class instructions on students activities.
PRESENTATION: The teacher provides salt samples of varying physical properties and asked the students to carefully examine the samples.

Step II

- Sample of the salt A is a chloride salt
- Sample of the salt B is a solid salt $CaCO_3$.
- Add $1cm^3$ of sample A to a few drop of cone H_2SO_4
- Add $1cm^3$ of Sample B to Cone H_2SO_4.
- Add the mixture of the chloride salt to MnO_2 powder then heat.
- Put a little amount of solid $CaCO_3$ in a test tube then heat.
- State your observation in each case
- Use ruler to measure the height of the solution.
- Use litmus paper to note any colour change

Dip a glass capillary tube into a clean lime water and insert it into the tube of the gas

Evaluation:

The teacher evaluates the lesson by asking questions such as:
1. What is the expected colour of a salt substance containing chloride Inference
2. Greenish Yellow salt substance indicates the presence.

CONCLUSION: The teacher concludes the lesson by summarizing the main points of the lesson.

LECTURE METHOD LESSON PLAN TWO

SUBJECT: CHEMISTRY
TOPIC: Qualitative analysis of Laboratory preparation of gases (2)
CLASS: SS II Students
AGE: 15-16 years
SEX: Boys/Girls
DURATION: 1 hour 20 minutes
TEACHING AIDS: Gases, CI_2, SO_2, H_2, HCI, HN_3, H_2S, $C0_2$ e.t.c
BEHAVIOURAL OBJECTIVE: By the end of the lesson Students should be able to identify gases presented through careful observation of their physical properties.
PREVIOUS KNOWLEDGE: Students learnt the concept of acid base and salt.
INTRODUCTION: The teacher introduced the lesson by reviewing briefly the concept of acid, base and salt. The teacher will at this stage of the lesson provide resources for learning, organizing students and resources for effective learning, provision of class instructions on students activities.
PRESENTATION: The teacher provides salt samples of varying physical properties and asked the students to carefully examine the samples.

Step II
The teacher explains the physical properties of each solid substances provided e.g. colour smell of size of particles.
Step III
The teacher draw an inference from the explanation in step II above
Evaluation:
The teacher evaluates the lesson by asking questions such as:
1. What is the expected colour of a salt substance containing chloride Inference
2. Greenish Yellow salt substance indicates the presence of?

CONCLUSION: The teacher concludes the lesson by summarizing the main points of the lesson.

LECTURE METHOD LESSON PLAN THREE]

SUBJECT: CHEMISTRY
TOPIC: Laboratory preparation of gases.
CLASS: SS II Students
AGE: 15-16 years
SEX: Boys/Girls
DURATION: 1 hour 20 minutes
TEACHING AIDS: Gases, CI_2, SO_2, H_2, HCI, HN_3, H_2S, $C0_2$ e.t.c

BEHAVIOURAL OBJECTIVE: By the end of the lesson Students should be able to identify gases presented through careful observation of their physical properties (i.e crystalline etc.).

PREVIOUS KNOWLEDGE: Students learnt the concept of acid base and salt.

INTRODUCTION: The teacher introduced the lesson by reviewing briefly the concept of acid, base and salt. The teacher will at this stage of the lesson provide resources for learning, organizing students and resources for effective learning, provision of class instructions on students activities.

PRESENTATION: The teacher provides salt samples of varying physical properties and asked the students to carefully examine the samples.

Step II

The teacher explains the physical properties of each solid substances provided e.g. colour smell of size of particles.

Evaluation:

The teacher evaluates the lesson by asking questions such as:

1. What is the expected colour of a salt substance containing chloride Inference

CONCLUSION: The teacher concludes the lesson by summarizing the main points of the lesson.

LECTURE METHOD LESSON PLAN FOUR

SUBJECT: CHEMISTRY
TOPIC: Laboratory preparation of gases.
CLASS: SS II Students
AGE: 15-16 years
SEX: Boys/Girls
DURATION: 1 hour 20 minutes
TEACHING AIDS: Gases, CI_2, $S0_2$, H_2, HCI, HN_3, H_2S, $C0_2$ e.t.c
BEHAVIOURAL OBJECTIVE: By the end of the lesson Students should be able to identify gases presented through careful observation of their physical properties (i.e crystalline etc.).
PREVIOUS KNOWLEDGE: Students learnt the concept of acid base and salt.
INTRODUCTION: The teacher introduced the lesson by reviewing briefly the concept of acid, base and salt. The teacher will at this stage of the lesson provide resources for learning, organizing students and resources for effective learning, provision of class instructions on students activities.
PRESENTATION: The teacher provides salt samples of varying physical properties and asked the students to carefully examine the sample.

Evaluation

The teacher evaluates the lesson by asking questions such as:

1. What is the expected colour of a salt substance containing chloride Inference
2. Greewich Yellow salt substance indicates the presence of?
3. What is the expected colour of the CO_2

CONCLUSION: The teacher concludes the lesson by summarizing the main points of the lesson.

LECTURE METHOD LESSON PLAN FIVE

SUBJECT: CHEMISTRY
TOPIC: Laboratory preparation of gases.
CLASS: SS II Students
AGE: 15-16 years
SEX: Boys/Girls
DURATION: 1 hour 20 minutes
TEACHING AIDS: Gases, Cl_2, SO_2, H_2, HCl, HN_3, H_2S, $C0_2$ e.t.c

BEHAVIOURAL OBJECTIVE: By the end of the lesson Students should be able to identify gases presented through careful observation of their physical properties (i.e crystalline etc.).

PREVIOUS KNOWLEDGE: Students learnt the concept of acid base and salt.

INTRODUCTION: The teacher introduced the lesson by reviewing briefly the concept of acid, base and salt. The teacher will at this stage of the lesson provide resources for learning, organizing students and resources for effective learning, provision of class instructions on students activities.

PRESENTATION: The teacher provides salt samples of varying physical properties and asked the students to carefully examine the samples.

Evaluation:

The teacher evaluates the lesson by asking questions such as:

1. What is the expected colour of a salt substance containing chloride Inference
2. Greewich Yellow salt substance indicates the presence of?

CONCLUSION: The teacher concludes the lesson by summarizing the main points of the lesson.

LECTURE METHOD LESSON PLAN SIX

SUBJECT: CHEMISTRY
TOPIC: Laboratory preparation of gases.
CLASS: SS II Students
AGE: 15-16 years
SEX: Boys/Girls
DURATION: 1 hour 20 minutes
TEACHING AIDS: Gases, CI_2, $S0_2$, H_2, HCI, HN_3, H_2S, $C0_2$ e.t.c

BEHAVIOURAL OBJECTIVE: By the end of the lesson Students should be able to identify gases presented through careful observation of their physical properties (i.e crystalline etc.).

PREVIOUS KNOWLEDGE: Students learnt the concept of acid base and salt.

INTRODUCTION: The teacher introduced the lesson by reviewing briefly the concept of acid, base and salt. The teacher will at this stage of the lesson provide resources for learning, organizing students and resources for effective learning, provision of class instructions on students activities.

PRESENTATION: The teacher provides salt samples of varying physical properties and asked the students to carefully examine the samples.

Step II

The teacher explains the physical properties of each solid substances provided e.g. colour smell of size of particles.

Evaluation:

The teacher evaluates the lesson by asking questions such as:

CONCLUSION: The teacher concludes the lesson by summarizing the main points of the lesson.

APPENDIX F

No	X	Y	XY	$(\overline{X}-X)^2$	$(\overline{Y}-Y)^2$
1	15	26	390	0.25	1.96
2	16	26	416	0.25	1.96
3	15	27	405	0.25	5.76
4	15	25	375	0.25	0.16
5	15	25	375	0.25	0.16
6	16	23	358	0.25	2.25
7	16	23	368	0.25	2.25
8	15	22	330	0.25	6.25
9	15	26	390	0.25	1.96
10	16	26	416	0.25	1.96
11	15	20	300	0.25	2.25
12	16	25	400	0.25	0.16
13	16	26	416	0.25	1.96
14	15	26	390	0.25	1.96
15	16	24	384	0.25	0.25
16	16	24	384	0.25	0.25
17	16	27	432	0.25	5.76
18	16	22	352	0.25	6.25
19	15	23	345	0.25	2.25
20	15	25	375	0.25	0.16
Total	310	491	7,611	5.00	63.92

$$r = \frac{\varepsilon XY - NXY}{N\delta x\delta y}$$

But

$\overline{X} = \frac{310}{20} = 15.5$

$\overline{Y} = \frac{491}{20} = 24.6$

$$\delta x = \sqrt{\frac{\sum(x - x)2}{N}}$$

$= \sqrt{\frac{5}{20}}$

$= 0.5$

$$\delta y = \sqrt{\sum\frac{(Y - Y)2}{N}}$$

$= \sqrt{\frac{63.92}{20}}$

$= 1.8$

$r = \frac{7{,}611 - 7595}{(20)\ (0.5)\ (1.8)}$

$= \frac{16}{18} = 0.89$