EVALUATION OF THE EFFECTS OF LABORATORY AND DISCUSSION METHODS ON PERFORMANCE AND RETENTION OF CHEMISTRY STUDENTS IN SECONDARY SCHOOLS KADUNA STATE, NIGERIA

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A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DOCTOR OF PHILOSOPHY IN EDUCATION (CURRICULUM AND INSTRUCTION)

DEPARTMENT OF EDUCATIONAL FOUNDATIONS AND CURRICULUM, FACULTY OF EDUCATION,

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DECLARATION

I hereby declare that the thesis entitled "EVALUATION OF THE EFFECTS OF LABORATORY AND DISCUSSION METHODS ONPERFORMANCE AND RETENTION OF CHEMISTRY STUDENTS IN SECONDARY SCHOOLS, KADUNA STATE, NIGERIA" has been carried out by me in the Department of Educational Foundations and Curriculum, Faculty of Education, Ahmadu Bello University, Zaria. No part of this thesis was previously presented for another degree or diploma at this or any other institution. The information derived from the literature has been duly acknowledged in the text and a list of references provided.

Lucy Omoka ADEJO _____ _____ _____
P16EDFC9026 Signature Date

CERTIFICATION

This thesis entitled EVALUATION OF THE EFFECTS OF LABORATORY AND DISCUSSION METHODS ON PERFORMANCE AND RETENTION OF CHEMISTRY STUDENTS IN SECONDARY SCHOOLS KADUNA STATE, NIGERIA by Lucy Omoka Adejo meets the regulations governing the award of degree of Doctor of Philosophy in Education (Curriculum and Instruction) of the Ahmadu Bello University Zaria, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This work is dedicated to my loving husband Adejo Daniel Stephen. Thank you for your effort towards my success.

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ABSTRACT

The study evaluated the effects of laboratory and discussion methods on the performance and retention of Chemistry students in Senior Secondary Schools in Kaduna State, Nigeria. Six objectives were formulated for the study amongst which were to: determine the pre-test and post-test performance of Chemistry students taught using laboratory method in Senior Secondary Schools in Kaduna state, Nigeria, examine the pre-test and post-test performance of Chemistry students taught Chemistry using discussion method in Senior Secondary Schools in Kaduna state, Nigeria and compare the retention ability of Chemistry students exposed to laboratory, discussion and conventional methods in Senior Secondary Schools Kaduna state, Nigeria. In line with the objectives, six corresponding research questions and hypotheses were formulated for the study. Relevant literatures on the key variables of the study were reviewed. The study was carried out using quasi experimental design with the target population of eighteen thousand, one hundred and thirty eight (18,138) SSII Chemistry students and a sample of two hundred and seven (207) Chemistry students was arrived at using purposive sampling techniques. Data for the study was collected through the administration of pre-test, post-test and retention test using teacher made test tagged "Chemistry Students Performance and Retention Test (CSPART) and the instrument was validated by the researcher's supervisors, experts from the field of Chemistry and social science, test and measurement. The data collected were analyzed using statistical package for social science (SPSS) version 20. Demographic variables were analyzed using frequencies and percentages while mean and standard deviation were used to answer the research questions. Paired sample t-test, independent t-test and one way analysis of variance (ANOVA) were used to test the hypotheses advanced for the study at 0.05 level of significance. The findings of the study amongst others revealed that the post test performance of students taught Chemistry using laboratory method was significantly higher than their pretest scores (p-value 0.000<0.05), students taught Chemistry using discussion method performed significantly better in the posttest (p-value 0.010<0.05) also, the retention ability of students taught Chemistry using laboratory method was significantly better than those taught using discussion and conventional method (p-value 0.000<0.05). In view of the findings from the study, conclusion was drawn that laboratory method motivate students to actively participate in the learning activities rather than been passive listeners. Discussion method enabled students to discuss and share ideas with each other. It was also concluded that performance of students taught Chemistry using laboratory method was significantly better than those taught Chemistry using discussion and conventional method, similarly, the retention ability of students taught Chemistry using laboratory method was also better than those taught using discussion and conventional method. Based on these, it was recommended among others that the laboratory method of teaching should be emphasized in the teaching of chemistry ahead of other teaching methods for tangible results and teachers should be encouraged to actively involve students in relevant participatory laboratory activities since it has been found to improve performance in Chemistry.

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OPERATIONAL DEFINITION OF TERMS

Laboratory Method	Process of learning where students are actively involved in practical demonstration and observation in the laboratory.
Discussion Method	Process of learning which involves sharing of ideas, experiences, facts and opinion between a teacher and students or students to students' interaction.
Conventional Method	Oral presentation of information, skills and ideas to students by the teacher while the students remain passive recipients.
Teaching Method	Way and manner a teacher generally organizes and presents the subject matter for attainment of instructional objectives
Retention	Ability of the students to recall back the learned concepts after the administration of the posttest and during the retention test.

LIST OF ABBREVIATIONS

ANOVA	-	Analysis of variance
AT	-	After Treatment
BT	-	Before Treatment
CG	-	Control Group
CSPRAT	-	Chemistry Student Performance and Retention Test
DM	-	Discussion Method
EG1	-	Experimental Group One
EG2	-	Experimental Group
FME	-	Federal Ministry of Education
LM	-	Laboratory Method
MEST	-	Ministry of Education Science and Technology
NECO	-	National Examinations Council
NTI	-	National Teachers Institute
TMRAS	-	Training Manual for Research Assistants
NCCSSS	-	National Chemistry Curriculum for Senior Secondary Schools
NERDC	-	Nigeria Educational Research and Development Council
WAEC	-	West Africa Examinations Council
X0	-	Pre-test
X1&X2	-	Treatment for Experimental groups
X01 & X02	-	Conventional Method
X3	-	Post-test
X4	-	Post, post-test

CHAPTER ONE
INTRODUCTION

1.1 Background to the Study

Chemistry is a science based discipline offered in the SeniorSecondary School Level of Education in Nigeria; it is one of the core science subject offered by students who want to take to professions in health, engineering and sciences. It is the scientific study of interaction of chemical substances that constitute atoms or the subatomic particles: protons, electron and neutrons. It is an integral part of the science curriculum taught at the SeniorSecondary School as well as higher institutions. At this level, it is often called "General Chemistry" which is an introduction to a wide variety of fundamental concepts that enables students to acquire tools and basic skill useful at the advanced level. One of the objectives of science education is to develop students' interest towards science and technology. Chemistry is central to many of the scientific fields of human endeavors: therefore, teaching of Chemistry should be given serious attention. In view of this, Chemistry school curriculum calls for means of its effective implementation in order to achieve the desired objectives for which it is intended.

Most nations developed because of the role played by teachers through teaching, hence, teaching must be done in a way students will perceive, understand and retain what has been learnt to reflect higher scores for meaningful application of knowledge at different situation. No discussion of the curriculum is complete without suggestions about methods of its effective implementation. Teaching

methods are very vital to the teaching-learning process in schools as it bridges the gap between the teacher and the learners and reduces anxiety. Teaching method is a systematic way of presenting subject matter and learning experiences. It describes how a teacher organizes and present teaching materials to the learners. The methods adopted by the teacher may either promote or hinder effective teaching and learning process. A good and effective teaching method leads to achieving the instructional objectives. However the dominant use of conventional method by Chemistry teachers have begun to be increasingly criticized and this have paved way for wide spread growth of student-centered learning as an alternative method (Roya, Mohammed and Faramarz, 2014).

The study of Chemistry is very important, as well as selection of teaching methods so as to enhance proper and effective implementation of Chemistry curriculum at the Secondary Schools level in Kaduna State in particular and in Nigeria in general. There are varieties of teaching methods for teachers to choose from depending on the situation. There are methods that are teacher centered and student-centered ranging from individualized instruction, role play, project, discovery, and so on. Some of these methods of teaching are more appropriate and peculiar to a particular group than others. In the Secondary School curriculum, the recommended methods for teaching Chemistry are: demonstration, project, fieldtrip, laboratory, inquiry, discussion methods and so on.

To ensure that all students have the necessary background to learn a subject, teacher can present basic information in a conventional way. The

conventional method is a process of verbally delivering a pre-planned body of knowledge to a class in a one way teacher to student style (Petty, 2010). The conventional method is where information passes from the notes of the teacher into the notes of the students, and may not pass through the brains of either. It is where the teacher presents the factual information in a direct and logical way. The conventional method can be effective where the lessons involve a collection of large body of information to be disseminated to a large group of learners in a shortest time with minimal cost. It is one of the most efficient teaching methods for presenting many facts or ideas in a relatively short time. A topic which involves the use of conventional method has to do with elaborating, simplifying, clarification among others, as it allows for easy coverage of the syllabus. The conventional method allows for little or no students' participation. The teacher, in this method gives an introduction and a summary ensuring that information is specific to learners. In active learning process, learning is no longer a standard process, but it transforms into a personalized process. It permits students to assimilate and accommodate information; it is the way people learn when they are left alone. Here the skills of problem-solving and critical thinking are developed. The researcher observed that the countries in the world are witnessing rapidly changing developments in information, science and technology in all walks of life. Human face various problems in their lives and they try to find particular ways to solve these problems. In this respect it is important for students to be prepared for the future by facing real-life problems in their learning environment and producing appropriate solutions to these

problems. What is expected from education is to enable individuals to become an effective problem solver in their actual lives (Herreid, 2007). The most convenient method with regards to reaching this aim in teaching and learning environment is the laboratory method. The basis of laboratory method is rooted in Dewey's 'learning by doing and experiencing' principle.

The laboratory method is a teaching method which is suitable for teaching and learning of Chemistry and other related science subjects at the SeniorSecondary Schools. This method is usually used as a forum for science teachers and their students within a classroom, to interact with materials under controlled condition when seeking answers to problems in nature (Maikano as cited in Maikano, Sale and Amos, 2015). Laboratory method have the potential to develop students understanding of concepts, scientific applications, scientific attitudes, practical skills, scientific habits of mind, understanding how Chemistry and scientists work, ability to formulate scientific questions, ability to form hypotheses, ability to design and conduct investigations, ability to formulate and revise scientific explanations, communication skills and/or ability to defend scientific arguments, interest and motivation skills in teamwork, imagination and creativity, and technical skills in the use of equipment (Kwabena, 2013).

Therefore, modern educational trends in education emphasize laboratory activities which include experiments, because the laboratory is physically associated to science topics that entail practical experiments on the one hand, and the accomplishment of the objectives of science teaching on the other. Recent years have witnessed

numerous discoveries and inventions through experimentation, which is a vital element of science basis. Experimentation can work effectively only through utilizing the laboratory in the teaching process (Kizito, 2017). The American Chemistry study project emphasized the laboratory work in teaching Chemistry, likewise, the British field project showed great interest in using laboratory to conduct experiments in teaching Chemistry to develop the students manual skills.

Discussion method involves the active participation of students in the learning process. Discussion involves two-way communication between participants. In the classroom situation, the teacher and students all participate in the discussion. With the current teaching trends, the teacher act as a facilitator who leads and guides the interactive session. During discussion, the teacher spends some time listening while the students spend sometimes talking. The discussion is therefore, a more active learning experience for students than the conventional method as it helps to foster students involvement in what they are learning, which might contribute to desired attitudinal changes. Discussion may be used in the classroom for the purpose of lesson development, making students apply what they have learnt or to monitor students learning by way of feedback. In discussion, problem is initiated while teacher motivates and encourages students to interact with each other and find solution to problems.

Discussion also is the verbal exchange of views, opinions or ideas between two or more people. (Abubakar, 2011). Discussion may also be used, following a lecture or laboratory method to help students apply what they have learnt. For instance, following a lecture on “water”, the teacher may lead a discussion directing students’ attention to the laboratory where some of the equipments for water purification are found and the

reason for using each type of equipment. The discussion method also provides opportunity to monitor student learning. The answers provided by students and the question they ask reveal the extent and quality of learning taking place. Discussion used in this way should follow after other methods of teaching in the classroom such as conventional or laboratory method. In this way, discussion contributes to the transfer of learning and enhances students' performance.

Performance in Chemistry is the demonstration of students' ability to attain certain level of instructional objectives out of classroom experiences. Performance is also the measure of accomplishment in a specific field of study (Okwara, Paul and Ikyaani, 2015). Performance is the direct, systematic observation of an actual accomplishment and rating it according to the pre-established performance criteria (Angyaye, 2007). Students, when asked to perform a task or create a product, they are assessed on both the product and the end result of their work. The researcher is of the opinion that appropriate use of teaching methods could develop their thinking ability, motor skills, maximumachievement in certain types of learning such as speech skills and so forth.

In assessing students' performance, school location is considered as one of the factors that affect performance in SeniorSecondary Schools. Onah (2011), say environment reflect on students' performance. Therefore, for the students to carry his learning effectively and efficiently, it is necessary that learning takes place in a conducive location. No academic institution can operate efficiently and produce worthy products without the input of well trained and qualified teachers. Though, all necessary input might be available and in good order, the contribution of teachers need to be given

priority, Abe and Audu (2013), says education cannot be provided by just anybody, it requires a teacher who plans and delivers the lessons or instruction in such a way that objectives can be achieved. When education objectives are attained by the learners, their performance in the study of Chemistry will be enhanced, hence they will be able to retain and recall learnt concepts. Retention is the ability of one to remember what he has learnt in the later time. Retention of learned information is having the information stored in long-term memory in such a way that it can be readily retrieved, for example, in response to standard prompts (Bichi, 2012). Retention is an instructional-level measure of success. It is an act of retaining something or an ability to remember learned concepts or ideas (Stenger, 2016). For the purpose of this study, retention is the ability to keep or retain the knowledge of the concept of water learnt and to be able to recall it when required. Retention in Chemistry is not acquired by mere rote-memorization but through appropriate teaching methods (Ajayi and Ogbeba, 2017).It is the process by which new information is transferred from our short term to our long-term memory. In other words, it's all about making new knowledge stick. It's not new science, either. 70% of any new information is lost within 24 hours if we don't make an effort to retain it. When teaching is characterized by rote-learning, and mere memorization, learned concepts are not long retained or do not have effect in change of behavior. Retention according to Wachanga (2013) has been found to improve the performance of students.

Although, the two terms (performance and retention) look alike but they are two sides of a coin. Performance is the direct and systematic observation of an actual accomplishment of given task while retention means storage of information over some

period of time, this time period is called retention interval (Bichi, 2012). This shows that high retention leads to good performance in students' achievements, thus appropriate methods such as laboratory and discussion should be employed by Chemistry teachers to enable learners develop critical thinking skills, decision making, and be more active in the learning process. The more active the learner is involved in the learning process, the better he or she retains what is taught (Paul, 2009). It is against this background that the researcher is motivated to conduct a study on the evaluation of the effect of laboratory and discussion methods on performance and retention of Chemistry students in SeniorSecondary Schools Kaduna State, Nigeria.

1.2 Statement of the Problem

Education should aim at helping the learner acquire appropriate skills, knowledge, abilities and competencies, both mental and physical as equipment for the individual to live in and contribute meaningfully to the development of his society and the country at large (FRN, 2013). This can only be achieved when Chemistry is properly and adequately taught using the appropriate methods. Chemistry is one of the core science subjects in Secondary Schools and it has come to be recognized as the axial on which progress and development of both the individual and the nation depend on.

Results of studies conducted by different scholars and researchers in the field of Chemistry have shown that students continued to perform poorly in Chemistry (WAEC, 2016); this has become a public concern and not good news to reckon with. Chemistry being a core subject in the study of science and technology should be given attention in the teaching and learning process. Chemistry, to most, is a complex and difficult subject, the tendency for most students is to consider the subject as one that is boring, thus

creating lack of interest in the subject. Various reasons have been deduced to explain the lack of interest and poor performance in Chemistry and these include the teacher-centered methods used by teachers, non-availability of resource materials, poor classroom management, insufficient scientific equipments in the Chemistry laboratories, Idris and Rajuddin (2012). Dahiru, (2013) reported that, the prevailing teaching method in many Nigerian Secondary Schools is the lecture method. This method according to him does not allow active students' participation in Chemistry lessons; rather students memorize and regurgitate facts and concepts without acquiring the basic understanding of the concepts.

Studies have confirmed that the negative attitude of students towards a particular subject is as a result of poor teaching methods usually employed by teachers in their classrooms. Analysis of Chemistry students' performance during WAEC examinations in Nigeria from 2012 to 2017 indicated persistent failure in Chemistry. It was observed that of the total number of 208,232 Chemistry candidates who registered and sat for the examination between the listed years, only 23.7% passed Chemistry at credit level in 2012, 20.7% passed in 2013, 36% passed in 2014, 33.5% in 2015, 25.3% and 21.7% passed in 2016 and 2017 respectively (Yusuf 2012). This situation is so discouraging realizing the fact that Chemistry is a core science subject and the National university commission (NUC) prescribed pass at credit level before admitting any student into any science based courses at the university level.

There is need to search for effective instructional strategies that are likely to improve and remedy students' academic performance in Chemistry. This therefore

necessitated the need by the researcher to explore effective instructional methodologies that have been neglected by Chemistry teachers but recommended for the teaching and learning of Chemistry in the SeniorSecondary School Chemistry curriculum. These methods are likely to improve and remedy students' academic performance in Chemistry at the SeniorSecondary School level of education. As such, this study was conducted to evaluate the effects of laboratory and discussion methods on Chemistry students' Performance and retention in SeniorSecondary Schools in Kaduna State, Nigeria.

1.3 Objectives of the Study

The objectives of the study are to:

1. determine the pre-test and post-test performance of Chemistry students taught using laboratory method in Secondary Schools in Kaduna State, Nigeria;
2. examine the pre-test and post-test performance of Chemistry students taught using discussion method in Secondary Schools in Kaduna State, Nigeria;
3. determine the effect of laboratory method on students retention ability in Chemistry when compared with conventional method in Secondary Schools in Kaduna State, Nigeria;
4. determine the effect of discussion method on students retention ability in Chemistry when compared with conventional method inSecondary Schools in Kaduna State, Nigeria;
5. compare the performance of Chemistry students exposed to laboratory, discussion and conventional methods in Secondary Schools in Kaduna State, Nigeria

6. compare the retention ability of students taught Chemistry with laboratory, discussion and conventional methods in Secondary Schools in Kaduna State, Nigeria.

1.4 Research Questions

The following questions were raised and answered in the cause of the study:

1. What is the pre-test and post-test performance of students taught Chemistry using laboratory method in Secondary Schools in Kaduna State, Nigeria?

2. What is the pre-test and post-test performance of students taught Chemistry using discussion method in Secondary Schools in Kaduna State, Nigeria?

3. What are the effects of laboratory method on students' retention ability in Chemistry when compared with conventional method in Secondary schools in Kaduna State, Nigeria?

4. What are the effects of discussion method on Students' retention of water in Chemistry when compared with conventional method in Secondary Schools in Kaduna State, Nigeria?

5. What are the effects of laboratory, discussion and conventional methods on the performance of Chemistry students inSecondary Schools in Kaduna State, Nigeria?

6. What is the difference in the retention ability of students taught Chemistry with laboratory, discussion and conventional methods in Secondary Schools in Kaduna State, Nigeria?

1.5 Hypotheses

The following hypotheses were formulated and tested in the study:

H_{01}: There is no significant difference in the pre-test and post-test performance of students taught Chemistry using laboratory method in Secondary Schools in Kaduna State, Nigeria

H_{02}: There is no significant difference in the pre-test and post-test performance of students taught Chemistry using discussion method in Secondary Schools in Kaduna State, Nigeria

H_{03}: There is no significant difference in the retention ability of students taught Chemistry using laboratory methods and those taught using conventional method in Secondary Schools in Kaduna State, Nigeria

H_{04}: There is no significant difference in the retention ability of students taught Chemistry using discussion method and those taught using conventional method in Secondary Schools in Kaduna State, Nigeria

H_{05}: There is no significant difference in the performance of students taught Chemistry using laboratory, discussion and conventional methods in Secondary Schools in Kaduna State, Nigeria.

H_{06}: There is no significant difference in the retention ability of students taught Chemistry using laboratory, discussion and conventional methods in Secondary Schools in Kaduna State, Nigeria

1.6 Significance of the Study

This study is considered significant in a number of ways to education stake holders such as Chemistry teachers, Curriculum developers, Ministry of education officials, Examination bodies, textbook publishers, parents, students, and future researchers. Through the findings of this study, Chemistry teachers will enhance their

competence and professional development in their Chemistry classrooms, thereby helping students understanding of Chemistry concepts through laboratory and discussion method. It will also help teachers to learn the characteristics of the conventional method, both its pros and cons, and provide some practical alternatives teaching methods for teachers who do not think the method fit their teaching. Similarly, the outcome of this study will help the teacher to check and improve on the methods and quality of teaching which will in turn improve the performance of students in any examination.

The findings through publications at conferences will help teachers in evaluating their performance in the teaching of the various aspects of Chemistry curriculum contents. The result of the study will reveal the aspects of the Chemistry curriculum that are not properly implemented by teachers. This may lead to improvement in such aspects of the curriculum for greater performance among students. Chemistry teachers will also utilize the outcomes of this study to promote effective ways to motivate and increase students learning of Chemistry by guiding the students in their approach to problem solving and creating conducive environment for competency in laboratory and discussion methods among students.

The findings will also help in suggesting the way forward in the inculcation of laboratory and discussion methods in learning Chemistry concepts as well as aid towards solution to arising problems. It is hoped that results of this study will encourage Chemistry teachers to plan sequence, and properly organize Chemistry contents in order

to enhance and encourage students to avail themselves to the learning opportunities that are available in laboratory and discussion methods.

Curriculum developers will find the result of this study important as it will provide them with insight into the effectiveness of laboratory and discussion methods in achieving maximum results. It will enable them to utilize the factors that are found to promote effective ways of using laboratory and discussion methods of teaching and developing materials that could effectively enhance the teaching and learning of Chemistry. This research will equally be of great use to the curriculum developers as it will help them to suggest relevant teaching methods for teaching different topics in the curriculum. Hence, students' performance will improve through the use of appropriate teaching methods. The study will be of value to Federal Ministry of Education and States ministries of Education. The findings will stimulate them to re-orient their Chemistry teachers through workshops and seminars/conferences on the use of laboratory and discussion methods in their teaching process, to enhance the quality of teaching and learning at the Secondary School level. It will also help them to check teachers' improvement on the method and quality of teaching which would in turn improve the performance of students in both the internal and external Chemistry examination.

The result of this study will be beneficial to examination bodies such as Nigeria Educational Research and Development Council (NERDC) that carryout research, discuss and disseminate research findings, thereby use the result of the research to facilitate effective teaching and learning of Chemistry curriculum and seek to inculcate team spirit in students through laboratory and discussion methods. This therefore will

lead to improvement in the way curriculum is being implemented by the teachers for greater performance among the students.

Textbook publishers will benefit from the findings of this research as materials that foster interactivity and cooperation among students in Chemistry. Laboratory and discussion activities could be given priority in books and teaching.

Parents, through the findings of this study will be able to advice their wards on the strategies that students can adopt for effective critical analysis of issues or problem solving in Chemistry. Teaching of Chemistry using laboratory method will enable students to search and find community actual problems, propose sound solutions to those identified problems and change them throughout their life. The practical experience will develop analytical, creative, participatory decision making, leadership and active citizenship skills and abilities among students, willingness and skills for realizing personal responsibility as a citizen.

Students will also benefit from the study by ensuring they participate actively when the methods of laboratory and discussion is employed by their teachers to teach Chemistry, as the methods turn the students from passive information recipients to active, free self-learner and problem solver. Students will be able to analyze various situations independently, express and defend personal opinions and attitudes and develop action plans. By means of laboratory and discussion methods, some students' attitude in relation to such areas as problem-solving, thinking, group works, communication, information acquisition and information sharing with others will be affected positively. The outcomes of the study will afford students the skill to both merge their old knowledge with new knowledge and to develop their judgmental skill in

a specific discipline or environment. Students will also acquire the skills of time management, facing realities and expressing emotion.

The result of this work will be uploaded in the net to assist future researchers intending to carry out similar studies on other topics in Chemistry with diversified group of subjects; it will inform them of the usage and challenges of laboratory and discussion methods of learning Chemistry at the Secondary School level of education.

1.7 Scope of the Study

This study focused on the "Evaluation of the Effects of Laboratory and Discussion Methods on Performance and Retention of Chemistry Students in Secondary School in Kaduna State, Nigeria". The study was delimited to two teaching methods namely; laboratory and discussion methods in teaching Chemistry. The study was limited to four (4) public Secondary Schools in Zaria education zone of Kaduna State, Nigeria. The respondents for the study were confined to Chemistry students in public Secondary School II from Government Secondary SchoolDakace, Government Secondary School Dogon Bauchi snr, Government Secondary School Tudun Jukun and Barewa College. The choice of SSII students was informed by the fact that they were not preparing for any external examination and they had been sufficiently exposed to Chemistry curriculum through the conventional method and was readily available in the school throughout the session.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter presents the review of related literatures on the evaluation of the effects of laboratory and discussion methods on Chemistry students' performance and retention in Secondary Schools in Kaduna State, Nigeria. The review was carried out under the following sub-headings: Conceptual frame work such as: Concept of Chemistry, teaching methods, conventional method, laboratory method, discussion method, retention and performance as it relates to Chemistry. Theoretical Framework such as: Constructivist learning theory, Cognitive load theory, Ausubel's theory of learning, Cultural-Historical Activity theory was reviewed.

The chapter also reviewed related issues like Chemistry curriculum for Secondary Schools, importance of teaching methods in the implementation of Chemistry curriculum, factors to be considered in the selection of teaching methods in Chemistry,

students performance in Chemistry, Chemistry instruction in Secondary Schools, overviews of conventional method, advantages and disadvantages of conventional method, qualities of conventional method, exploring the origin of laboratory method, importance of laboratory activities, goals and objectives of laboratory activities, improving Chemistry through laboratory activities, importance of laboratory activities in learning Chemistry, advantages and disadvantages of laboratory method, discussion method, forms of discussion, task in discussion, procedure for planning and using discussion, advantages and disadvantages of discussion, roles of the teacher in discussion, retention in Chemistry, relevance of laboratory and discussion method in teaching Chemistry. The chapter concluded with the discussion of empirical study and summary.

2.2 Conceptual Framework

A conceptual framework is a written or visual presentation that explains either graphically, or in narrative form, the main things to be studied, such as, the key factors, concepts or variables and the presumed relationship among them. According to Mutai (2010), a conceptual framework is a hypothesized model identifying various variables and the relationship among them. This study is based on the assumption that laboratory and discussion methods of teaching affect students' performance in Chemistry. The methods employed by teachers in teaching is very important because teaching methods adopted by a teacher can promote or hinder effective learning in the classroom. Methodology has the ability to sharpen the mental activities which are the basis of social power or may discourage initiatives and curiosity thus making self-reliance and survival very difficult. There are different types of teaching methods that can enhance effective

and efficient teaching and these methods include: field trip, discussion, assignment, lecture, laboratory, demonstration, project, play-way and many more.

The teaching method used by a teacher is very important to make a lesson succeed, and as a result, teachers employ varying teaching techniques and methods to accomplish their educational objectives since no one method of teaching will be able to work all the time and under every circumstance (Bartz and Miller, 2011). The way that instructions are presented to students in the classroom is referred to as methods of instruction according to Idris and Rajuddim (2012). According to him, these methods of instruction fall into two categories, namely: student- centered teaching and teacher centered- teaching methods (traditional method). Student-centered method generally entails students' active participation during the instruction while the traditional method makes learners to be passive recipient of information. Some educational objectives can be better achieved by traditional method of teaching while others by student centered method. This implies that there is not one best or particular teaching method to yield effective and efficient teaching.

2.2.1 Chemistry

It is possible to fix the birth of Chemistry as a science in the second half of the eighteenth century, with only one exception, the contribution of Robert Boyle (1627 – 1691), who lived much earlier. The third period, the foundation of chemical disciplines, started around the early nineteenth century with the development of Chemistry along the different sectors or disciplines that are still characteristic of present day Chemistry. The era of modern Chemistry began at the close of nineteenth century, when the history of Chemistry coincides in great part with

that of the contributions of Nobel laureates. This division based on centuries is not formal but is justified by the fact that at the end of the eighteenth and nineteenth centuries many new revolutionary ideas were developed, which changed the course of chemical thought completely. The short history of Chemistry presented in this research particularly examined the evolution of concepts developed in the nineteenth century. Many of these ideas started just at the beginning of the century and reached a certain maturity by its end. Therefore, an analysis of the developments over the period of just 100 years provides an almost complete picture of the course of the evolution of Chemistry. In a few cases (the chemical bond, catalysis, and industrial applications), the fundamental concepts were not developed until the first part of the twentieth century. In these cases, in order to show the evolution of the ideas, we have to take a step into the twentieth century (Sarma, 2016). It introduced the experimental facts, developed in the previous centuries, that were the basis of later ideas that contributed towards the transformation of Chemistry into a science during the second half of the eighteenth century, when only 17 elements where known and the Phlogist theory had many followers. In studying the history of Chemistry, it is possible to note some common paradigms through the anecdotes that accompanied the description of the lives of several scientists: the fact that each new idea had to wait many years before being accepted, the key role played by the discovery of new instrumentation and by ideas developed outside Chemistry (which had a cascade effect on innovation), the fact that many discoveries were made by very young scientists (during work on their doctoral theses or earlier), and the roles of chance and mistakes that brilliant minds succeeded in interpreting (Fabrizio and Ferrccio, 2014).

Chemistry has a crucial role in the rapid development in science and technology. Since the Nigeria "vision 2020" emphasized the role of science technology and innovation (STI) in a modern economy, then, good performance in the subject and other sciences is crucial. The relevance or importance of Chemistry amongst the science subjects is formidable, hence the need for proper teaching of the subject in the Secondary Schools so that students' scores in internal and external examination will be high, thereby making the candidates' entrance into higher schools easier (Sola and Ojo, 2009). In Nigeria, Chemistry laboratory work is given a central and distinctive place in the teaching and learning at the Secondary School level. Although Chemistry laboratory experiments occupy a massive share in the curriculum time and resources, doubts have been raised about their effectiveness or their real educational value, as students continue to perform poorly in the subject. Derek (2007), reported the seriousness of the deplorable performance of Secondary School students in Chemistry and identified the persistent use of inappropriate method of instruction as one of the major short-coming affecting the learning and higher achievement in Chemistry. It is observed that teachers try to evade the laboratory work considering it a waste of time; they don't appreciate the significance of the laboratory methods nor do they include them in the final tests. Therefore, teachers overlook the laboratory work (El- Rabadi, 2013). Chemistry is undoubtedly the central science that forms the basic foundation to many disciplines. In spite of this important position of Chemistry among other science and science related disciplines, students' academic performance of secondary students in the subject has for many years remained a matter of serious concern for professional bodies, educational administrators

and government. Efforts made through research to discover the remote causes of the persistent failure revealed that Secondary School Chemistry teachers mainly adopt the traditional method in the teaching and learning of Chemistry.

2.2.2 Teaching Methods

A teaching method comprises the principles and methods used by teachers to enable students' learning. These strategies are determined partly on subject matter to be taught and partly by the nature of the learner. Aliyu, (2015) defined teaching methods as a systematic procedure employed by teachers in an attempt to help learning takes place. This usually includes the implementation of given theories of learning and the description of how a teacher organizes teaching. He stated further that the choice of teaching method depends on what fits you, your educational philosophy, classroom demographic, subject area(s) and school mission Statement. Traditionally, the teaching method is defined as a method of interrelated and independent activities of the educator and trainees aimed at realizing the learning goal. It is the purposeful actions of the teacher, organizing the cognitive and practical activities of the trainees and providing the solution of the learning tasks.

2.2.3 Conventional Method

The conventional method is mostly used by teachers in their teaching. This is when a teacher lectures straight either from notes. The teacher teaches directly from prepared notes with little or no movement, and sometimes with charts or graphs. It is a one-way flow of communication from the teacher to the students. It is teacher-centered method as the teacher dominates the most activity in the classroom because most of the talking is done by the teacher while the students remain passive listeners and taking

down of notes (Moore, 2010). In order to achieve the objectives of Chemistry, the constant use of the conventional method in teaching must be reviewed, and prescribed teaching methods in the Chemistry curriculum for Secondary School such as discussion and laboratory methods should be used to instruct learners and these calls for a student-centered active learning process. For teaching and learning to be successful, both the teacher and the learners have some activities to perform (Anyanwu and Iwuamadi, 2015). This will enable the learners take the responsibility of their learning and is given the opportunity to make decisions about various dimensions of learning process and to perform self- regulations.

Teaching methods are patterns of teacher behavior that occur either simultaneously or in sequence in a verified way. Choosing specific teaching methods that best achieves course objectives is one of the most important decisions a teacher faces. Knowing what methods are available and what objectives each method is best suited for, help teachers make this decision more easily. Conventional method is basically narration that will signify what we usually call explanation or description. A lecture is a narrative technique of delivering verbally a body of knowledge according to pre prepared scheme of action as cited by Adejo (2015). In lecture method, fact or principle is presented orally to groups of students who take notes, have little or no participation in learning, and experience passive rather than active learning." The lecture technique should not be confused with the supplying of information by the teacher. According to Walker (2012), there are three main reasons to use the lecture format: To transmit information; to create interest; and to promote understanding.

Lecture can be used to effectively survey the structure of knowledge in a particular area as well as suggest the connection between cases and real decision-making, reaching students at an emotional level, and provides necessary motivation for learning difficult material (Bimbola, 2010). Good lectures have certain qualities that determine the effectiveness of the method. Lectures can be good or bad depending on these qualities. He further elaborated that one aspect of the lecture method which causes some concern is that it effectiveness is dependent on the skills of the individual lecturer. The ability to organize and explain a topic does not come naturally except to a fortunate few individuals.

Virtually everyone who has education would have encountered poor lecturers, and would have seen the damages that they can do to their students. Similarly, Rahman (2011) said that lecture method allowed more material to be covered, in particular the multiple and varied exemplars that have been associated with superior acquisition and transfer. It is the most economical method of transmitting knowledge, but it does not necessarily hold the students' attention or permit active participation. However, lectures can be effective, if supported by texts and other references but it is significantly less common in primary and Secondary Schools. He opined that laboratory sessions are more effective in stimulating the students' interests and assessing their understanding of the material. On the other hand, lectures also communicate the intrinsic interest of the subject matter. The speaker can convey personal enthusiasm in a way that no book or other media can. Enthusiasm stimulates interest and interested people tend to learn more.

However, it may be kept in mind that only well prepared and well presented students welcome lectures. It cannot be used in teaching higher cognitive and effective

processes such as attitude. As a means of teaching, it is suitable only for mature students and only in specific subjects. It can be used where the teacher does not require establishing each and every point in his lecture during instruction. But it is generally not suitable for younger students, as in teaching them the teacher must know that each point is understood before proceeding to the next. Hussain (2014) quote Bloom as: the value of lecture method depends on the specific objective of the teacher. If the teacher wishes to communicate information, the lecture method is reasonably efficient, but if the teacher desires to develop the power of critical thinking, problem solving ability and attitudinal change, the laboratory method is superior.

Teachers need several different kinds of knowledge i.e. knowledge about the subject matter, knowledge about curriculum goals; knowledge about the challenges students are likely to encounter in learning these ideas; knowledge about how ideas can be represented effectively; and knowledge about how students' understanding can be assessed. The effectiveness of a method can be determined by studying the degree to which its objectives are achieved. The objectives of lecture are:

1. Exercising/gaining control of the class
2. Highlighting major ideas
3. Setting the stage for forthcoming activities
4. Showing one's own interest for the subject
5. Providing a model of good communication skills.

There are different types of lecture methods as described by Kumar (2009)

1. The expository lecture: It is what most students think of when they hear that the teacher lectures a lot. The instructor does most of the talking and at times allows students to ask questions for clarification.

2. Illustrated lecture: It can take up different forms for example; transparencies, filmstrips, slides, projected and non-projected pictures, diagrams, maps, charts, and blackboard writings. These are meant to catch the attention of the learners and must be prepared carefully. They must be visible to the audience and the audience should know the relevance of the illustration. Illustrations become part of the lecture when they are well planned well prepared and well presented.

3. The Lecture – Recitation: In this, teacher does most of the talking, but often stops and asks students specific questions or requests students to read prepared materials. In the lecture - recitation, the direction of interaction is either teacher to class, teacher to individual student, or individual student to teacher.

4.Lecture-cum-Demonstration: This type of teaching serves a positive purpose as the students' keen observation during demonstration enables them in comprehension. Demonstrations are often useful when concepts are being developed. It is helpful in teaching of skill-subjects, sciences and languages. Lecture cum demonstration is suited particularly to the students who have limited ability to think abstractly.

5. The interactive lecture: It encourages student-to-student interaction. In this the instructor begins with a 15 to 25 minute mini-lecture and then asks the students to form learning groups and complete an assignment based on the mini-lecture.

6. Lecture cum buzz sessions: In this process the whole class is divided into small groups (five to ten students) after the lecture is delivered. For few minutes (usually five

minutes) buzz session is organized on particular aspect of the lecture. The group leaders then report back to the whole group. As the students are much involved, the content of the lecture becomes more meaningful to the students. It is evident that lecture method is flexible because teacher can adopt themselves to the subject matter, achievement level of students, time limit, available apparatus and equipment in a very short period of time.

A lecture can be an effective method for communicating theories, ideas, and facts to students (Winstanley and Bjork, 2016). The primary aim of every lecturer should be to make sure that they communicate effectively with their students. In order to do so, a lecturer should try to achieve clarity of delivery, clarity of expression and clarity of structure. Gage and Berliner (2008: 401) about lecture method suitability are briefly presented as follows:

1. The basic purpose is to disseminate information
2. The material must be organized and presented in a particular way for a specific group.
3. It is necessary to arouse interest in the subject.
4. Students need to remember the material for a short time.
5. It is necessary to provide an introduction or directions for learning task that is going to be taught through some other teaching methods. Teachers need to orient their students properly at the start of lecture. Such orientation is particularly important at the start of a course, module or series of lectures, when the students are meeting for the first time. Lecture method is based on certain psychological principles as quoted by Walker, (2012). The learner should meaningfully react to the stimuli of the teacher's teaching so that learning takes place.

1. The teacher should be aware of the needs of the learner.

2. Since attention span of students is not too long, the teacher should keep up the interest by injecting humorous comments, modulating his voice, and summarizing the topic.
3. The teacher should have a realistic idea of his own teaching ability and the learning capacities of the students. Learning outcomes is essential for growth and progress in the lecturing process.
4. As it is an auditory medium the concept is converted into mental pictures by the students and then understood. The teacher should take time to build these mental pictures, connecting the new concepts with the known, moving from simple to difficult ideas, banking on his communication ability.
5. The teacher uses an understandable language and it depends on factors such as difficulty level of vocabulary, right examples, fluency, pronunciation of words, rate of speaking etc.
6. The conventional method can be an effective method of instruction due to its versatility. It is virtually limitless in application, either to situation, subject matter, or student age and learning ability. At the same time it can be one of the least effective methods if improperly used. The lecture method is more effective when visual aids, models, or some form of group participation are used.

The conventional method is one out of several teaching methods, though in schools it is often considered the prime method of instruction. The conventional method is convenient and usually makes the most sense, especially with larger classroom sizes. This is why the standard for most university courses, when there can be several hundred students in the classroom at once; conventional method enables the teacher to address

most people at once, in the most general manner, while still conveying the information that the teacher feels is most important, according to the lesson plan (Academy, 2015).The conventional method is a process of verbally delivering a pre-planned body of knowledge to a class in a one way teacher to student style (Petty, 2010). He also said a conventional method is where information passes from the notes of the teacher into the notes of the students, without passing through the brains of either. It is where the teacher presents the factual information in a direct and logical way. The teacher, in this method gives an introduction and a summary ensuring that information is specific to learners.

It is a one-way flow of communication from the teacher to the student. It is teacher-centered as the teacher dominates the most activity in the classroom because most of the talking is done by the teacher while the students remain passive listeners and taking down of notes. It is regarded as a didactic approach or talk-chalk. The conventional method of teaching is an economic means of transmitting factual information to a large audience though there is no guarantee that effective teaching learning will take place. The teacher may ask few or no question in the process as the method does not require the use of instructional material. Students are denied the opportunity of developing manipulative skill as the method is only concerned with verbal presentation of concepts and ideas to the learners (Akumu, 2011).

Conventional method is automatic in form, it allows little or no room for active student's participation, and gives little or no feedback to the teacher as to the effectiveness of his presentation. Conventional method is widely used in Nigerian Secondary Schools, but it does not result in a noticeable change in attitude held, while

retention of information after conventional by students are minimal in terms of content. The conventional method of teaching enables teachers deliver preplanned lesson to the students with little or no instructional aide. The teacher succeeds in addressing the class and his talk dominates the activity of the class. According to Stofflett (2009), the conventional method is often called traditional or teacher-centered approach of teaching which sometimes is regarded to as a one person show with a captive but largely uninvolved audience. This method of teaching pays more attention on teachers which in turn helps to decrease students learning interest to a greater extent.

The conventional teaching method is mostly used for students in the tertiary institutions, where the material to be learned is given in a completed form to the learner. The teacher dishes out the information to the learners, and in most cases, the learners are passive recipient of the information. The conventional method therefore, reverses the concept of education which maintains that the best learning is that which results from purposeful activity. Furthermore, anything which puts the students in a passive situation and stresses activity for the teacher rather than the learners is bound to benefit the teacher more than the student (Edwin, 2011). Although the conventional method can be an effective and efficient teaching method, it has a number of disadvantages. The conventional method does not lead to maximum achievement in certain types of learning such as, speech skills, cooperative group thinking, and motor skills. These mentioned skills can only be developed efficiently by students through practice.

2.2.4 Laboratory Method

Chemistry is an experimental science which relies primarily on the harmony

between theory and Practical (Muhammad, 2014). The understanding of concepts in practical Chemistry will assist in enhancing students' understanding of Chemistry (Ikeobi, 2010). Students have difficulty in making connections between the sub disciplines of Chemistry and the link between practical work and theory is often less than obvious because of the approach adopted by teachers in instruction. In Chemistry teaching, the importance of harmonizing laboratory work with theory cannot be overemphasized. Omolade (2010) stated that; if the academic achievement of students is to be enhanced, learners must have a deep understanding of the basic concepts behind practical task they engaged in. This is because the observations and experiment students carry out are meant to confirm some theories and the application of concepts. Meaningful learning occurs when learners comprehend concepts and are able to connect them with previous knowledge (Ausubel, 2000). When students learn Chemistry meaningfully, their ability to reflect on their own learning and make adjustments accordingly fosters deeper learning. Deeper learning is the key strategy through which students find meaning and understanding from course material and experiences (Moss and Brookhart, 2012) which in turn may result to competence of knowledge transfer to other domains and how to apply the knowledge in answering questions and resolving problems. The laboratory method is an active learning method which enables students to become aware of and determine their problem solving ability and learning needs, to learn, to be able to make knowledge operative and to perform group work in the face of real-life problems. Laboratory method turns the student from passive information recipient to active, free self-learners and innovators, and it slides the emphasis of educational programmes from teaching to learning. The

laboratory method enables the student to learn new knowledge by facing the problems to be solved. The laboratory method has long had a distinctive and central role in the Chemistry curriculum and Chemistry educators have suggested that many benefits accrue from engaging students in Chemistry laboratory activities (Kwabena 2013). By means of laboratory method, some attitudes of students in relation to such areas as problem-solving, thinking, group work, communication, information acquisition, and information sharing with others are affected positively. Laboratory method is an activity-based; student centered teaching method where students learn by carrying out activities in the laboratory (Omosewo, 2012). These activities include, touching, seeing, feeling, weighting, measuring, demonstrating, carrying out tests/experiments and any other practical activities in the laboratory. A deeper understanding of the science and technological processes can be achieved through laboratory activities which encourage active participation and serve to develop critical thinking and also provide concrete experiences to substantiate the theoretical aspect that might have been taught. Mkpa (2011) maintains that laboratory activities provide exercises/problems based upon real physical situations and also appreciation of the various methods used in experimental science. Such methods include understanding competence in the use of apparatus, training in awareness of the problems involved in precise laboratory work. These methods help learners to construct definitions of concepts, formulate relevant questions and theories relating to any assumptions and arguments used in the experimental process. According to this author, the laboratory teaching method serves the following purposes: Motivating students by stimulating interest, developing understanding of

scientific inquiry and expertise, inculcating scientific attitudes into students and encouraging social skill development.

The laboratory in the school has been defined by several authors in different ways. Maduabum, (2009) defined a laboratory as a place where scientific exercises are conducted by the science teachers for the benefit of the students (learners). The laboratory exercises include; experiments, and other activities which help the students in acquiring scientific skills. Ezeliora, in Omiko (2015) defined science laboratory as a workshop where science is done or where scientific activities are carried out under conducive environment. She alsoperceived the laboratory as a place where science equipment, materials or instruments are housed for security and safety. Igwe, (2009) observed that a laboratory can be in-door such as the sufficiently designed and equipped room found in most schools or outdoor involving such places as riverside, workshop, field and even market for carrying out scientific studies. He further Stated that whatever the type of laboratory employed in science teaching, the same laboratory experience should be attained, and that is a participation in the series of experimental, observational and demonstrating activities which provide opportunity for students to develop understanding of practical and theoretical concepts through solutions of problems.

A laboratory is a classroom with a special period of time equipped and set apart for practical or experimental studies to take place (Omiko, 2015). He defined the laboratory as the heart of a good scientific programme which allows students in the school to have experience which are consistent with the goals of scientific literacy. This implies that science teaching and learning cannot be completely done in a Secondary

School where an equipped laboratory is not available. Ufondu, (2009) observed that the laboratory is an indispensable organ of the school, if effective teaching and learning of the science subjects are to be achieved.

Lazarowitz and Tamir as cited in Kwabena (2013), characterized cooperative learning in the Chemistry laboratory as peer tutoring in small investigative groups. They suggested that, in such laboratories, the learning environment is highly affected by the fact that the students are free to study at their own pace, ask questions, interact with one another and with their teachers, and seek information from various sources. On the other hand, the traditional Chemistry laboratory is very task-oriented and thus, leaves the students with very few opportunities to engage in the mentioned activities. Research indicated that student achievement and motivation for the study of Chemistry improves potentially if students are active participants in constructing their own knowledge and in learning to use that knowledge to analyze scientific processes (Kwabena, 2013). Practical activities are designed to make the students active participants. Such methods are now extensively used in physics education but are in their infancy in chemical education (Alexander cited in Bala 2011). However, the role of the teacher in the laboratory method of learning being operated in a student-centered manner is to facilitate learning activities by guiding students. Teachers fulfill this role by monitoring discussions, asking questions, helping the resolution of occasional conflicts, enabling the participation of each group members to classroom discussions, giving examples when required, preventing disorderliness in discussion classrooms and making evaluation (Maxwell and Dornan, 2015).

Oxford Advanced Learners Dictionary Special Price Edition (1998), defined laboratory as a room or building used for scientific research, experiments, demonstration, testing and analyzing of data etc. However, whatever is done in the science laboratory is to obtain or acquire skills that would help to advance scientific knowledge which subsequently would lead to the development of the human society. Dienye and Gbamanja in Omiko (2015) observed that laboratory method of teaching is an activity involving a two-way approach carried out by one or more persons through the exercise and experimental approaches both of which are useful in science teaching. The experimental approach provides an opportunity for students to seek information using experimental procedures. These procedures call for careful observations and interpretation of data. It has the qualities of questioning, investigating and confronting the unknown. Ufondu (2009) and Omiko (2015) observed that the use of the laboratory in science teaching has the following benefits:

1. Laboratory teaching makes the students/learners to learn about the nature of science and technology in order to foster the knowledge of human enterprise of science and thus enhance the aesthetic and intellectual understanding of the child. Dienye and Gbamanja (2009) opined that science is known to be a way of doing certain things by the observation of natural phenomena, quantifying the observed things, integration of such quantities and interpretation of the results in order to make useful meaning out of the exercise. The students can identify cause and effect relationships and in this process develop important skills.
2. Learning scientific inquiry skills that can be transferred to other spheres of problem solving (that is acquisition of problem solving skills). One of the basic goals of science

education is to help students learn skills that can be applied to other life situations in future. It thus follows that the exercise of transfer of such learning condition must have something in common with the situation to which it will be applied.

3. Students learning to appreciate and in fact, emulate the role of the scientist through acquisition of manipulative skills. The students should be allowed to investigate by:

a. Indirect observation of objects and materials for the acquisition of mental as well as manipulative skills, example measuring substances, using weighing balances pictures, cylinder.

b. Through multiple trials, students can in the process of fiddling with materials and activities without stated theories arrive at useful conclusions.

c. Given a known theory, students can be guided to observe some phenomena selected by the teacher and from such observation make predictions that are likely to occur.

4. Developing interests, attitudes and values by considering what science entails, it is clear that a field experience has the best potential for stimulating a life time interest in science in the students when accorded the chance for personal experience by handling the real things. Students interest in science increases as they yearn to investigate and explore more about their environment. According to Hancy in Omiko (2015), eight (8) aspects of scientific attitudes exist, all of which can be nurtured in the science laboratory in the school. They are; (i) curiosity (ii) opened mindedness (iii) objectivity (iv) intellectual honesty (v) rationality (vi) willingness to suspend judgment (vii) humility and (viii) reverence for life. Queensu (2008), States that science educators believe that the laboratory is an important means of instruction in science since late 19th century. Laboratory instruction is considered essential because it provides training in

observation, supplies detailed information, and aroused pupils' interest. It also went further to say that "developing and teaching in an effective laboratory requires as much skill, creativity, and hard work as proposing and executing a first-rate research project. Omiko (2015) and Ufondu (2009) were of the same opinion where they observed that laboratory teaching is sometimes used in conjunction with large lecture courses so that students may acquire technical skills and apply concepts and theories presented in the lecture. Omiko (2015) stated that "hands-on experience encourages students to develop a spirit of inquiry and allows them to acquire scientific skills and the right attitude to handle scientific tools and materials. Science laboratory provides students with the richest experiences which they will transfer to the society and their various places of work. It helps in providing the students the opportunities to practice science as the scientists do. In order for the laboratory to be effective, students need to understand not only how to do the experiment, but why the experiment is worth doing, and what purpose it serves for better understanding of a concept, relation, or process. Shulman and Tamir in Omiko (2015), listed five groups of educational objectives that may be achieved through the use of the laboratory in science teaching.

1. Skills: manipulative skills, inquiry skills, investigative skills, organizational skills and communicative skills.
2. Concept of mastery: For example, hypothesis, theoretical model, taxonomic category.
3. Development of cognitive abilities: Critical thinking, problem solving, application, analysis, synthesis

4. Understanding the nature of science – scientific enterprises, scientists and how they work, existence of a multiplicity of scientific methods, inter-relationships between science and technology and among the various disciplines of science.
5. Development of scientific attitudes: For example, curiosity, interest, risk taking, objectivity, precision, confidence, perseverance, satisfaction, responsibility, consensus, collaboration, and liking science. Based on the roles of the science laboratory in science teaching and learning, it implies that schools without laboratories, where students can carry out Biology, Chemistry and Physics practical would end up producing or graduating students who will have no knowledge of science practical required by the West African Examination Council (WAEC) and the National Examination Council (NECO) to pass the school certificate examination. Consequently, these students will lack the requisite requirement qualification for courses like Medicine, Engineering, Agricultural Science and any of the science related careers.

2.2.5 Discussion method

Discussion can be seen as talking over something from various points of view. It usually involves a group of individuals in a classroom setting. It is an interactive process involving the teacher and the student or among the students themselves. Discussion method is the method of teaching where the central and essential characteristic is interaction. During discussion session, students participate in the learning process by contributing to problems on, developing the factors associated with the problems, developing possible solutions to the problems, placing the solution into action and evaluating the results of the solution. When a problem or topic of a lesson is presented

for discussion, the teacher helps to direct the students' view towards the objectives of the lesson. Basically, the idea of discussion is to encourage active contributions by the learners that can be used to work toward a better understanding of the topic discussed. Discussion method is different from conventional teaching method. While the conventional method is a one-way flow of communication from the teacher to the students, discussion on the other hand involves the flow of information from one learner to another who represents the member of the classroom. Discussion method encourages creative and critical thinking and not memorization. It requires experience and confidence on the part of the instructor to allow for their ideas, questions and comments to be openly examined by the students.

Discussion encourages students' active participation in the class. Students generate varieties of ideas which lead to solution of the problem while the teacher moderates. For successful implementation of discussion method, every student should havebackground knowledge of what is to be discussed: otherwise, it will become a waste of time which may lead to lack of interest in the students.

Discussion is a type of activity, which involves breaking the class into small groups for effective talking on a topic, a problem or issue. It is thinking together process in which pupils talk freely to the teacher and to one another which makes it student-centered method since students participate actively. The role of the teacher is that of a moderator. There is flow of information from teacher to students, from student to student. The teacher should not allow individuals to dominate the discussion (Yusuf, 2012).

Group discussion may take a variety of forms such as small group, devil's

advocate, round table, panel discussion, opposing panel and debate (Adewuya in Yusuf, 2016). Some of the advantages of the method are sharing of ideas by students, development of social skills of talking and listening, clarification of ideas and promotion of team work. Despite all the above mentioned advantages, the demerits are numerous. Discussion can get out of hand if not properly controlled, the class may turn to a market place and confusion may arise as a result of poor management and informal nature of the organization. Discussion is a process of giving and taking, speaking and listening, describing and witnessing which helps expand horizons and foster mutual understanding (Stephen in Yusuf 2016). They explained further that it is only through discussion that one can be exposed to new points of view and exposure increases understanding and renews motivation to continue learning. Yusuf, Guga and Ibrahim (2016), noted that discussion is concerned with the development of knowledge, understanding or judgment among those people taking part in it. They believe that discussion is more serious than conversation because it requires students to be "mutually responsive" to the different views expressed. They emphasized that discussion is highly "disciplined and concerned" forum in which people come together to resolve some issues or problems that are important to them. Dillion in Yusuf, Guga and Ibrahim, (2016) saw discussion as an important way for people to affiliate with one another to develop the sympathies and skills that make participatory lessons possible.

Discussion is a method of teaching that works on the principle that many people are to put heads together in terms of knowledge and ideas to find solutions to specified problems. The activities of the discussion group are to be regulated and directed by the

teacher or an appointee of the class. Information does not become knowledge automatically until learners have been actively involved in its processing (Akinleye, 2010). Discussion teaching method is a design that provides opportunity for interaction between teacher and students, it centers on shared exchange of ideas in class. It gives opportunity for all to sit and listen as well as talk and think, in other words, students in a discussion class are not passive listeners neither is the teacher a sole performer. In discussion, students are allowed to develop thinking ability, learn to evaluate ideas, concepts, principles, procedure, programmes and even policies on the basis of clearly set criteria. Green, (2012) sated that discussion teaching method provides opportunity for students to talk positively and share ideas on common topics. The teacher in this regard directs and re-directs the information and the trend of thought of the learners. This implies that discussion gives room for active participation of the learners by thinking individually and actively making input and contributions.

Discussion method is a particular type of teaching method in which the teacher leads the students into active participatory learning activities in the classroom (Effeh, 2015). He further explained that the educator raises the problems in order to initiate students' interaction with each other while pursuing the solution to the problem posed. The aim of this method is to come up with a solution by way of directing the learners to participate and contribute to the teaching process.

2.2.6 Retention

Stockley, (2013) defined retention as the mindful, thoughtful approach embarks on to fascinate, improve, attract and retain information with the skills and abilities to meet current and future challenges. Retention is concerned with identification of skills

and abilities, retention, supervision and management, development of skills to increase performance. Thus, retention as a wider concept focuses on how best an individual can entice, preserve, attract, improve, manage, retain and maintain necessary talent.

2.2.7 Concept of Academic Performance

Academic performance is the outcome of education and the extent to which a student, teacher or institution has achieved their educational goals. Academic performance is commonly measured by examinations or continuous assessment. Individual differences in academic performance have been linked to differences in intelligence and personality. Students with higher mental ability as demonstrated by IQ tests and those who are higher in conscientiousness tend to achieve highly in academic settings. A recent meta-analysis suggested that mental curiosity (as measured by typical intellectual engagement) has an important influence on academic performance in addition to intelligence and conscientiousness. In the Standards for test construction, Sebbane , Belkadi and Benbernou (2019), reported that performance is viewed basically as the competence a person has in an area of content. This competence is the result of many intellectual and non-intellectual variables. Performance is the word preferred in the educational or psychometric fields, being sometimes characterized by the degree of inference required on the part of the student to give a response, and by the type of reference to a cognitive process made explicit in the measurement tool.

Cognitive psychology produced a shift from the study of behavior to its unobservable psychological antecedents. From the cognitive point of view, performance must be a construct that should refer to the different stages of knowledge acquisition. Educationally, performance may be defined as the mastering of major concepts and

principles, important facts and propositions, skills, strategic knowledge and integration of knowledge (Niemi, 2009). More systematically, performance is sometimes fractionated into knowledge components (Ruiz-Primo, 2008), like declarative, procedural and strategic. The declarative knowledge is composed of domain specific content, whereas the procedural and strategic refer to specific production systems. Anderson and Lebiere as reported by Salvador and Carmen in Amadi (2016) opined that the cognitive system has also the ability to monitor the process and use nonspecific strategies that are also a part of our proficiency in performance. These different components of performance develop conjointly and cannot be treated separately.

In summary, performance is the competence of a person in relation to a domain of knowledge. What we can externally observe is performance. The current view States that to reach a specific level of performance it may be necessary to bring into play complex cognitive tools like strategies, heuristics or skills. No doubt that the end result and the type of means to reach it must be correlated. It is believed that in Chemistry, the paramount thing in teaching and learning is students' performance and that makes them functional in the society, as such students' performance in Chemistry should be given topmost priority.

2.3 Theoretical Framework

The theoretical framework of this research study was hinged on theories of learning. Therefore, this research adopted the following theories of learning namely, constructivist learning theory, cognitive load theory, Asubel's Theory of learning and cultural –historical activity theory.

2.3.1 Constructivist Learning Theory

Constructivist leaning theory as postulated by Dewy, Piaget,Brunner, and Levygotsky (1878-1959), noted that humans generate knowledge and meaning from their experiences. The theory describes learning as an active and internal Process of constructing new ideas and understanding. It holds that people construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences. The learner must play an active role in taking on new knowledge (Millar, 2014). He or she has to make sense of the experiences and discourse of the Chemistry class and use it to construct meaning. The constructivist theory suggests that learners construct their ideas and understanding on the basis of series of personal experiences. Learning science at school level is not discovery or construction of ideas that are new and unknown to learners rather it is making what others already know your own (Millar, 2014). Experiences given in the laboratory during practicals can provide such opportunities for Chemistry students. For example, Barton (2009) suggested that, after an illustrative Chemistry laboratory experience, students are offered explanations, models and analogies from the teacher to help them in their efforts to construct their own understanding of what they have experienced.The primary criterion which a practical activity should satisfy is that of being an effective means of communicating the ideas it is intended to convey. A constructivist model currently serves as a theoretical organizer for many science educators who are trying to understand cognition in science.

Constructivism provides a perspective on teaching and learning science in classrooms, with a view to improving the effectiveness of science teaching in enhancing students' learning. Bada (2015) argued that, according to constructivism the most

important thing in science teaching and learning is providing students with learning environment that promotes their understanding of science by co-constructing and negotiating ideas through meaningful peer and teacher interactions.

The emphasis of learning activities means two things: student-centered teaching and laboratory –centered teaching(Miha, 2016). The center of instructional activities is the students themselves, so teacher-centered teaching does little good in students‟ learning processes. Activities such as performance of experiments (class experiments) and discussion about the results with peers can help students to build understandings. The laboratory –centered teaching (Chemistry Practical's) are crucial in constructing new knowledge and concepts by students. During these laboratory activities, students have opportunities to learn the procedure and skills that are facilitating conceptual changes that may lead to increased performance in Chemistry.

Constructivism transforms the student from a passive recipient of information to an active Participant in the learning process. Research indicated that students' achievement and motivation for the study of science improves drastically if students are active participants in constructing their own knowledge and in learning to use that knowledge to analyze scientific processes (Khan, Hussain, Ali, Majoka and Ramzan, 2011). Meaningful learning in the laboratory would occur if students are given sufficient time and opportunities for interaction and reflection. Also, Tobin (2009) and Ikeobi (2010), report that meaningful learning is possible from a given laboratory experiments if the students are given ample opportunities to operate equipment and materials that help them to construct their knowledge of phenomena and related scientific concepts.

The construction of deep scientific knowledge results from actively practicing science in structured learning environments, that is, where the nature of laboratory activities are taken into consideration. Secondary Schools in Kaduna State are categorized into boys‟, girls‟ and mixed schools. This categorization implies differing social and cultural learning environments. Individual learners‟ interactions with their peers are important to each learner's active construction process. Constructivism has many varieties: Active learning, discovery learning and knowledge building are three but all versions promote a student's free exploration within a given framework or structure. The teacher here acts as a facilitator, encouraging students to discover principles for themselves and to construct knowledge by working to solve realistic problems. The above is in line with the present study as it places emphasis on the ability of students to construct knowledge on their own minds through the process of Laboratory and discussion activities.

2.3.2 Cognitive Load Theory

This theory was propounded by Sweller in 1988. The theory suggests that learning happens best under conditions that are aligned with human cognitive architecture. The structure of human cognitive architecture, while not known precisely is discernible through the results of experimental research. Sweller built a theory that threats schemas, or combinations of structures that make up an individual's knowledge base. Schemas are acquired over a lifetime of learning, and may have other schemas contained within themselves.

The theory explained that learning requires a change in the schematic structures of long term memory and is demonstrated by performance that progress from Clumsy, error-prove, slow and difficult to smooth and effortless. The change in performance occurs because as the learner becomes incre asingly familiar with the materials, the cognitive characteristics associated with the material are altered so that it can be handled more efficiently by working memory. From an instructional perspective, information contained in instructional material must first be processed by working memory. For schema acquisition to occur, instruction should be designed to reduce working memory load. Cognitive load theory is concerned with techniques for reducing working memory in other to facilitate the changes in long term memory associated with schema acquisition. Sweller's cognitive load theory is best applied in the area of instructional design of cognitively complex or technically challenging materials. His concentration is on the reasons that people have difficulty learning materials of this nature.

Cognitive load theory has many implications in the design of learning materials which must, if they are to be effective, keep cognitive load of learners at a minimum during the learning process. Specific recommendations relative to the design of instructional material include:

1. Change problem solving methods to avoid means-ends approaches that impose a heavy working memory load, by using goal-free problems or worked examples.
2. Eliminate the working memory capacity to integrate several source of information.
3. Eliminate the working memory load associated with unnecessarily processing repetitive information by reducing redundancy.

4. Increase working memory capacity by using auditory as well as visual information under conditions where sources of information are essential (i.e. non-redundant) to understanding.

This theory is related to the study under consideration in the sense that related concepts in Chemistry are complex or technically challenging materials to the Secondary School students. The theory stands the ground to proffer solution on how to design instructions in the classroom in a way that will help to bring about proper understanding when students are exposed to complex or technically challenging materials.

2.3.3 Ausubel's Theory of Learning

The theory was developed by David Ausubel in 1960. Ausubel's theory of meaningful learning is a theory which stressed the importance of prior knowledge. The central emphasis in Ausubel's theory is meaningful learning which contrasts with rote learning and is only good for memorization and regurgitation of facts. The specific emphasis of the Ausubel's theory stresses that meaningful learning of new knowledge is dependent on what is already known. Specifically, new knowledge gains meaning when it can be substantively related to a framework of existing knowledge rather than being processed and filed in isolation. Ausubel theory provides the basis for constructing concepts which support the visualization of such conceptual framework and stimulate prior knowledge by making it explicit and requires the learner to pay attention to the relationship between concepts. Ausubel's assimilation theory of learning promotes the idea that people learn better if they can find meaning in the learning. Ausubel also maintains that concepts are of different depth which ranges from general to specific. A

general concept subsumes less general concepts which also include most specific concepts. Ausubel posits that concepts can be progressively differentiated by the level of specificity.

Ausubel believes that learning of new knowledge relies on what is already known, that is construction of knowledge begins with observation and recognition of events and objects through concept already stressed. He went further to say that we learn by contracting a network of concepts and to adding them. In this theory, concept map, developed by Ausubel and Novak, is an instructional device that uses this aspect of the theory to allow instruction of materials to learners; it is a way of representing relationship between ideas, images or words.

Ausubel's theory emphasized more on meaningful learning and that new knowledge gains meaning when it can be substantively related to framework of existing knowledge rather than being processed or filed. David Ausubel's theory of leaning is applied in the use of organizers and concept mapping. Ausubel believes that knowledge is heretically organized; that new information is meaningful to the extent that it is related to what is already known. Ausubel advocates the use of advance organizers as a mechanism to help link new learning materials with existing related ideas. Ausubel's theory of advanced organizers fall in two categories: comparative organizers and expository organizers.

Comparative organizers activate existing schemas and are used as a reminder to bring into working memory of what you may not realize is relevant. Comparative organizers are also used to integrate as well as to discriminate. Expository organizers are often used when the new learning materials is unfamiliar to the learner. They often relate

what the learner already knows with the new and unfamiliar material: this in turn is aimed to make the unfamiliar material more plausible to the learner. Ausubel believes that construction of knowledge begins with our observation and recognition of events and objects through concepts we already have. We learn by constructing a network of concepts and adding to them. Concept map is an instructional device that uses this aspect of the theory to allow instruction of material to learners: it is a way of representing relationships between ideas, images and words.

2.3.4 Cultural-Historical Activity Theory

The cultural- historical activity theory was founded by Flecha, Ramon, Sola and Marta, (2013). This theory addresses human activities as they relate to artifacts, shared practices and institutions although it goes beyond individual knowledge and decision making to take a developmental view of minds in context. Cultural-historical activity theory views an accumulated set of habit and values been demonstrated when people work, play, think and solve problems together hence the theory is appropriate for the study of educational practice. The theory relates with the present research because when solving a particular problem with others in Chemistry using laboratory and discussion methods, it brings about social interaction which plays a fundamental role in the development of cognition.

2.4 Chemistry Curriculum for Secondary Schools II

Chemistry is a branch of science subjects to be studied at the Secondary School level as prescribed by the National policy on Education. Chemistry refers to the total experiences that are given to students under the leadership of the teacher via the agency of the school. Chemistry is one of the science subjects upon which technological break-

through is built and is the pivot on which the wheel of science rotates. Chemistry is very important and helpful in fields of study such as medicine, agriculture, transportation, housing industries, etc. The study of Chemistry as a science subject makes life more meaningful by enabling people produce chemical product such as drugs, cosmetics, paints, soap, fertilizers, etc

Curriculum refers to the total experiences that are given to students under the leadership of the teacher via the agency of the school. Curriculum can also be seen as subjects comprising a course of study in schools or colleges. It is the lessons and academic content taught in a school or in a specific course or program. The philosophy of Chemistry curriculum is to present Chemistry as a subject that has relevance in everyday life and could prepare Chemistry graduates for scientific career in future (NERDC, 2008).

The Chemistry curriculum is based on the principles of equipping Secondary School graduates with basic knowledge and skills to appreciate the nature of Chemistry problems in any society and adequately prepare them for the challenges in the Nigerian scientific and technological problems. The curriculum is designed and structured in such a way that it spread from SSI-SSIII in a simple to complex way with in-built teachers and learners activities to be conducted for each of the topics listed in it.

The objectives of Chemistry curriculum according to NERDC (2008), is expected among other things to enable students to:

1. develop interest in the subject of Chemistry,
2. acquire basic theoretical and practical knowledge and skills,
3. develop interest in science, technology and mathematic,

4. acquire basic knowledge and skills develop reasonable level of competences in ICT applications that will engender entrepreneurial skills,

5. apply skills to meet societal needs of creating employment and wealth,

6. be positioned to take advantage of numerous career opportunities offered by Chemistry

7. be adequately prepared for future studies in Chemistry.

To be able to achieve the broad stated aims and objectives of Chemistry in Secondary Schools, the teacher has a sole responsibility. The teacher's goal with regards to achieving the objectives of the curriculum is to improve his/her competence in teaching the subject in the classroom in order to assist the students to learn and understand the basic Chemistry concepts. In order to achieve this task, Chemistry teacher not only plan, but also determines appropriate objectives for the students; device strategies that would assist students in the achievement of the objectives, implement the strategies, and determine how effective they are in the accomplishment of the set goals. Planning of what to teach and how to get about teaching it should be paramount in the heart of every committed and competent Chemistry teacher. A competent teacher is one who understands the place of learning experiences in the total curriculum, carefully plans and systematically varies students learning. He/she does this by planning his daily lessons from a pre-planned scheme of work which is a reflection of his/her understanding of the syllabus and the total curriculum organization. Units of instruction are drawn from the scheme of work, and taught according to the level of the students as well as to the syllabus and curriculum specification. Therefore, the major themes and

their topics for Chemistry curriculum for Secondary School II according to NERDC are shown on table 1

Table 1: Secondary School II Chemistry Curriculum

S/N	Theme	S/N	Topics
I	The chemical world	1.	Periodic table
		2.	Chemical reaction
		3.	Mass volume relationship
II	Chemistry and environment	4.	Acid-base reaction
		5.	Water
		6.	Oxygen
		7.	Air
		8.	Hydrogen
		9.	Halogens
III	Chemistry industry	10.	Oxidation reduction reaction

		11. Ionic theory
		12. Electrolysis
IV	Chemistry life	13. Hydrocarbons
		14. Alkanol

Source: Nigeria Educational Research and Development Council (2008)

2.4.1 Importance of Teaching Methods in the Implementation of Chemistry Curriculum.

The relevance of Chemistry to national development is inestimable. The teaching of Chemistry helps to imbibe scientific knowledge and stimulate science oriented attitude in learners. This attitude when directed to the world of work results in the development of the individual, the society and general standard of living of the citizenry. Therefore, the place of Chemistry knowledge and skills in economic and industrial development in the Nigerian society cannot be underestimated. According to Ikoku in Ifeanyi (2015), Chemistry is preoccupied with the molecular transformation, which matter, manifests. Actually Chemistry goes beyond processes in chemical industries to other industries such as fertilizers, petroleum, paper and pulp, iron and steel, cement, coal, glass, electronics and so on. It plays major roles in the vital sectors of the economy, execution of other professions and improvement of quality life. Chemistry contributes immensely also in the area of medicine, agriculture and criminology. All the above are indicators that Chemistry plays an important role in the economy and national development of any nation and as such should be considered essential and hence, be

fully involved in the task of national and human development of Nigeria.

What a teacher does in the classroom depends to some extent the degree of learning situation, however, students negative attitude toward learning may be related to the method of instruction. Correct use of an appropriate teaching method is critical to successful teaching and learning. The knowledge of how teaching methods affects students learning may help educators to select methods that improves teaching quality, effectiveness, and accountability to learners and the public. Organizing for effective teaching of Chemistry is centered on certain factors such as what to teach and how to effectively teach it. The teacher does not only teach the most important /relevant, meaningful and useful materials for specific students, he must also recognize and adopt a good well-researched method of teaching that guarantees better understanding and also stimulates and motivates the students to learn the subject without much difficulty.

2.4.2 Methods of Teaching Chemistry

The history of modern Chemistry teaching in Nigerian schools is relatively very recent, unlike most western countries where Chemistry teaching grows from the universities to high schools. In Nigeria, Chemistry teaching has its roots in the primary schools at different levels of education. The goals and objectives of Chemistry teaching are constantly changing as new information about how children develop; and as Chemistry and technology advance alongside the changes in the aspirations of individuals and the society. The following are some of the Chemistry teaching methods alongside their advantages and disadvantages. Demonstration is defined as a means of displaying materials to students. For example, when a Chemistry teacher shows the

action of carbon dioxide on a blue moist litmus paper, he is presenting a demonstration. Abdullahi in Musa (2010) agreed that demonstration is superior to lecture method. Even though the method emphasizes the teachers' activity (excluding completely students, manipulation in the process) it still involves experimentation. Okebukola and Adeyegbe in Musa (2010) agreed that experimentation is an essential aspect of Chemistry. Okebukola (2016) observed that people consider demonstration as: "Part and parcel of reception or expository teaching," but this depends on how it is presented.

Akpan (2009), opined that demonstration can be used where the apparatus is complicated, and where students can make mistakes in interpretation.

Advantages of demonstration method include the following:

1. A demonstration can be used to introduce a lesson.
2. Demonstration saves time.
3. Materials are also economized when large numbers of pupils are involved.
4. Demonstration method allows the teacher to teach activities that ordinarily would be too dangerous for students to carry out.
5. Through demonstration, teachers show how to avoid breakages and accidents.

Disadvantages:

1. Demonstration does not allow pupils to develop manipulative and psychological skills for carrying out activities on their own.
2. Pupils often have difficulties in seeing details of the object being demonstrated or apparatus being used as visibility is sometimes poor.
3. Less scope is covered in demonstration.

4. Demonstration involved Observation and, Observation alone cannot provide most of the scientific information that pupils need. From the above Statement, it is assumed that if laboratory method of instruction is adopted effectively, it will aid students to develop both cognitive and manipulative skills. This is because laboratory method is activity oriented. Nwokedibia in Musa (2010) Opined that laboratory activities are designed to guide students in their investigation must be well organized and result-oriented.

Discovery Method

Discovery method is one of the strategies of Chemistry teaching. Abdullahi and Bernaclete as cited in Musa (2010) defined the method in terms of exploration in the laboratory in which students perform such processes as observation, measurement, classification and finally students draw conclusion from the information. Abdullahi cited in Musa (2010), opined that there are two types of discovery methods of teaching namely: guided discovery and unguided discovery. Both approaches involve students in finding things for themselves. Ajewole in Yusuf (2013), carried out a study to determine the effects of guided discovery and expository instructional methods on transfer of learning. He found that the guided discovery group performed better with respect to the transfer of knowledge in biological concepts than the expository group students. Similarly, Regan and Childs (2013), in their study found that the guided discovery approach was significantly better for improving achievement of students. Davis (2009) examined the effects of two Chemistry instructional approaches on students' achievements. He used guided discovery and expository instructional approaches.

The result of the study revealed that the guided discovery method of instruction

improved students' achievement and enhanced positive attitude to Chemistry. The results of Davis (2009), on instructional strategies showed an increase in cognitive outcome when the discovery strategy was used. Also, the result of meta-analysis by Anderson (2010) pointed to positive result from discovery teaching. Discovery teaching method has the following advantages:

1. The method equips the students with a means of gaining knowledge on their own through active participation, and develops the mind by using it to solve problems.

2. The method also challenges students to find out information for them thus making instruction students-centered.

3. It encourages analytical thought and promotes development.

Disadvantages

1. It does not lead to coverage of a large amount of knowledge within a short time.

2. The method requires much fund to buy equipment and material.

Project Method

This method is meant to provide for the needs of individual students or sometimes small groups so that those with special abilities have opportunities to fulfill themselves. Musa (2010) defined project method as, a method of teaching used when the class has some central interest around which all the work of the class is centered for a given period.

Advantage

Unwachukwu cited in Musa (2010), said that one of the advantages of project method is that it gives recognition of other sources of knowledge besides the one given by the teacher, but it is costly and time consuming

Inquiry Method

This approach is described as the teaching of Chemistry through a process which encourages students to solve problems in a logical and systematic manner using the processes of Chemistry. Okam (2007), opined that these processes of Chemistry are characterized by various skills, such as observing, comparing, inferring, hypothesizing, experimenting data collection and interpretation of data.Arthur and Robert cited in Musa (2010), identified three types of inquiry methods of teaching Chemistry. They are the teacher guided inquiry, the modified inquiry and the free inquiry. The teacher guided inquiry is a method of inquiry in which instruction is earned out through the teacher's guide.

In this method, the students are assisted through carefully structured programme to perform some investigations in a step by step manner until they obtain a result. Okam (2007), observed that in this method, the teacher as a resource person is responsible for the planning and contriving of leaning situation to which the students respond and as the controller. He is also responsible for exposing students to learning experience that offer stimulating impetus to inquisitive minds. Wallington in Musa (2010), remarked that in the teacher guided experiment, the student could be encouraged to use the process of induction to reach valid conclusion after series of investigations and that while students are doing this, they are gradually being exposed to the processes of Chemistry. Nwadibia (2013) opined that laboratory activities which are designed to guide the students in their investigation must be well organized and result oriented.

In the modified inquiry: “the instructor outlines the problems and provides the needed materials and equipment but encourages students to works out the procedures themselves, while in free inquiry “the student originate the problem by himself and devices ways of solving it Arthur and Robert in (Musa, 2010).

Lecture (Conventional) as a Teaching Method:

Lecture is a teaching method where an instructor is the central focus of information transfer. Typically, an instructor will stand before a class and present information for the students to learn Wood and Tanner (2012). Sometimes, they will write on a board or use an overhead projector to provide visuals for students. Students are expected to take notes while listening to the lecture. Usually, very little exchange occurs between the instructor and the students during a lecture.

Advantages of Lecture as a Teaching Method:

1. Lecture is a straightforward way to impart knowledge to students quickly.

2. Instructors also have a greater control over what is being taught in the classroom because they are the sole source of information.

3. Students who are auditory learners find that lectures appeal to their learning style.

4. Logistically, a lecture is often easier to create than other methods of instruction.

5. Lecture is a method familiar to most teachers because it was typically the way they were taught.

6. Because most college courses are lecture-based, students gain experience in this predominant instructional delivery method. According to Lauret (2012) below are the advantages and disadvantages of lecture method.

Disadvantages of Lecture as a Teaching Method:

1. Students who are strong in learning styles other than auditory learning will have a harder time being engaged by lectures.

2. Students who are weak in note-taking skills will have trouble understanding what they should remember from lectures.

3. Students can find lectures boring causing them to lose interest.

4. Students may not feel that they are able to ask questions as they arise during lectures.

5. Teachers may not get a real feel for how much students understand because there is not that much opportunity for exchanges during lectures.

Discussion Method

Discussion is a process whereby two or more people express, clarify and pool their knowledge, experiences, opinions, and feelings. On the other hand, Rahman, khalil, Jumani, Ajmal, Malik and Sharif (2011) have observed that through discussion certain areas of one's particular viewpoint are compared and contrasted with others. The discussion class is intended to be a free give and take between teacher and students and among students on the current topic of concern in the course. It is characterized by probing questions from the teacher designed to elicit students interpretations, opinions, and questions. Petty and Jenson (2010) added that children learn to deal with facts through discussion method. Discussion is the thought of taking a problem and investigating all options with an ultimate objective to reach a mutual understanding of the problem. Teaching by discussion can be an effective mean of helping students apply abstract ideas and think critically about what they are learning. It is important to be clear about the objectives of holding the discussion and how it fits into the overall course. If

possible, rearrange the seating to allow students to face one another and not make the teacher the focus of the group. If students need to prepare beforehand, provide them with appropriate materials and thought questions to guide their preparation and this was stressed by Muhammad (2014) by saying that elaboration is essence of discussion. Lowman (2007) highlighted this view point that two types of teacher-student interchange are sometimes called discussion. In one, the teacher gives students an opportunity to clarify content or ask for opinions on related topic. In the other, the teacher asks questions requiring specific knowledge of course content. In a discussion class the students are actively involved in processing information and ideas. Since student-initiated questions are more common in discussion classes, their needs and interests are dealt with more readily and spontaneously than in other methods as pointed out by Gage and Berliner, (2008) that discussion is a forum, in which students can practice expressing themselves clearly and accurately, hearing the variety of forms that expression of the same idea can take, and criticizing and evaluating successive approximations to an adequate Statement. Discussion as highlighted by Hyman (2010) is used to arrive at the solution of problems and is characteristics of democratic societies. It occurs in a group form and usually involves six to ten persons. These persons perform one of two roles: leader-moderator who is typically the teacher, and participant: typically the students. Participants use the time to communicate with each other. Another student follows the group leader addresses his/ her remark to the whole group and each group member has the right to speak. A group member communicates with other members in the group by speech, and by facial expressions, gestures and body movement. Other members receive his/her message by listening and

by seeing the non-verbal signs. These processes of listening, speaking, and observing are the bases of discussion method. There are different types of discussion as mentioned by Konji (2012):

Round table discussion: It involves small number of persons nearly three to eight. It needs a moderator to introduce the members of the discussion group, present the problem to be discussed and keep the discussion moving. The leader's role is one of guiding the group rather than one of dominating it. The responsibilities of a moderator included the introduction of the topic, keep the discussion moving, and avoid having the group become sidetracked, avoid quibbling over irrelevancies, summarize and draw conclusions. While the responsibilities of members of the discussion group are to be well informed on the topic, speak informally while avoiding arguing and quibbling, stay with the topic under discussion, have sources of information available, back up Statements with facts, and help the group summarize its conclusions. In this type the responsibilities of the audience (students) are to listen attentively, withhold questions until presentation is completed, ask for clarification of ideas, ask for evidence on questionable Statements, confine remarks to the topic under discussion, and extend customary audience courtesies to members of the round table.

Panel discussion: A panel discussion is similar to a round table discussion in many ways, but different to exist. The responsibilities of the moderator are the same as in round table discussion. The procedure is more formal than that of the round table. It begins with a short Statement by each discussion member. Panel is more audience

oriented than round tables and each panelist is considered to be more or less an expert. Gage and Berliner (2008) also described the following as the objectives of discussion:

1. Thinking critically
2. Democratic skills
3. Complex cognitive objectives
4. Speaking ability
5. Ability to participate
6. Attitude change

It is the responsibility of the teacher to encourage students to participate in discussion. There cannot be a single answer to the question of what to do with child who dominates the discussion. But through careful and patient teaching, a teacher can bring the class to a point where they interact courteously with one another, without always agreeing with each other, and do so without raising their hands to speak. According to Dave (2012), "Giving students to paraphrase, clarify, and elaborate upon their own or other students' remark is a useful way to keep a discussion moving along and on target." Skills and attitudes may be stated as standards or guides that characterize harmonious, productive discussion. Therefore, one participating in a discussion should:

a. Listen with attention when others are speaking. Remain objective, open-minded, respect and accept the contributions of others, but think independently.

b. Prepare adequately for the discussion and be able to support ideas with factual evidence. Speak loudly and clearly enough for all to hear. Not be offended when the group does not accept one's ideas or suggestions.

c. Ask for clarification of ideas that are not understood. Have confidence in the ability of the group to come to a satisfactory decision and support the decision of the group once it has been made.

2.4.3 Students Performance in Chemistry

Chemistry students find it hard to connect the molecular formula, the geometric structure and the molecule characteristics together (Johnstone, 2013). Understanding the particular nature of matter, interpretation of symbols and visualizing spatial structures of molecules are essential skills students need for solving problems in science in general and Chemistry in particular, (Kwabena 2013). The performance of students in Chemistry at the Secondary School level has been poor and deplorable over the years. Analysis of students' performance in the Chemistry at SSCE level as noted by Njoku (2009) revealed that between 1980 and 1991, the annual average pass rate at credit level (grade 1-6) in 'Chemistry was 15.41%, while the absolute failure rate (grade 9) was 61.82%.

Okebukola (2016) findings on factors affecting students' performance in practical Chemistry revealed such factors as students' non participation in Chemistry laboratory activities, teachers' attitude to Chemistry as a subject and inadequacy of laboratory equipments for practical work. Successful completion of Chemistry is a prerequisite for many graduate and professional programs in science, technology, engineering, and mathematics, yet the failure rate for this branch of Chemistry is considerably high. Kwabena (2013) observed that lack of practical activities by Chemistry students has resulted in poor communication and observational skills. The absence of these skills gave rise to students' poor performance in Chemistry. Regan and Childs (2013) observed that when students were regularly engaged in practical activities

they tend to have enhanced interest, but as the frequency slowed down to no laboratory activities for weeks, the interest also went down. Reasons why students could not be engaged regularly in laboratory activities were included in Okebukola's (2016) twelve factors. Laboratory adequacy which is a school environment factor has been reported to affect the performance of students in Chemistry. (Olugbuyi, 2017; Adeyegbe, 2013) argued that students tend to understand and recall what they see more than what they hear as a result of using laboratories in the teaching and learning of science.

Science educators have given various definitions of academic performance. Ogunleye, Awofala and Adekoya (2014), defined academic performance as the knowledge attained or skills developed in school subject, usually designed by means assigned by teacher. Usman (2010) described academic performance as the assessment of how much students have learned, the extent to which a student has acquired certain information or mastered skill usually because of planned information or training.

Academic performance according to Eniayewu (2013) is what students are able to gain in the SeniorSecondary School Certificate Examination (SSCE) after completion of Senior Secondary instruction. Ogunboyede (2013), has defined academic achievement as when teacher spend larger amount of time in direct teaching of reading Mathematics, Science and Social Studies rather than in music art or social awareness.Ogunleye, Awofala and Adekoya (2014) defined achievement to be the level of an individual's educational growth in a test when compared with the scores of others of the same level. Generally, academic achievement means accomplishment or proficiency of performance in a given skill or body of knowledge.

The major objectives of teaching are to promote the understanding of the concept being taught with a view to applying such knowledge to real life situations and promote academic achievement of students in Science. According to Eta in Ogunleye, Awofala & Adekoya (2014), the consistent poor performance and negative attitude towards science attest to the fact that science teaching procedure has not been properly done. Hence, the concepts being taught are not properly understood and leads to poor performance in science subjects. Therefore, science teaching needs appropriate method of instruction that will best achieve the aim of science teaching, thus, improving the performance and enhancing the positive attitude towards science subjects such as Chemistry.

Scientific achievement simply means the use of scientific knowledge acquired by an individual to solve a problem confronting him in the society. Maikano, Sale and Amos (2016) expressed the view that most important aspects of scientific achievement are those concerned with the development and skills needed to make decision and solve societal scientific and technological problems. According to Musa (2010), academic achievement is the quality of result produced by students as reflected in their examination scores. In this study therefore, academic performance of students in Chemistry is considered. That is, the study determined the effectiveness of laboratory and discussion method on the academic performance of students in Chemistry among Senior Secondary two students compared to lecture method.

2.4.4 Chemistry Instruction in Secondary Schools

Instructional methods according to Yusuf, (2012) should be selected based on type of instructional objectives that are expected to be achieved. Objectives set at the

psychomotor and cognitive domains will require learner-centered teaching methods such as discussion, play way, project methods of teaching and so on, such methods according to Chika (2012), connected students' world with learning pursuit in the classroom. However, it is not sufficient to have experience if such is not discussed and shared, they may be forgotten so soon. There are also, other criteria that should be considered in the selection of teaching methods such as the subject to be taught, the size and number of students, time available for the teacher to be able to cover the content of the lesson, interest of the learner, age of the learner, ability of the teacher, intellectual capacity, students background and materials available.

Instruction in Chemistry is done through practical and theory work. Typically, the term practical mean experiences in school settings where students interact with materials to observe and understand the natural world. The practical are mainly done as student experiments in the laboratory and as teacher demonstrations either in laboratories or in classrooms, while the theory is often done in the classroom (Twoli, 2016). Wellington (2012), describes Chemistry practical as teacher demonstrates or as class experiments where all learners are on similar tasks, working in small groups or a circus of experiments with small groups of learners engaged in different activities, rotating in a carousel. In Secondary Schools, laboratory activities are designed and conducted to engage students individually, or in small groups (student experiments) and in large-group demonstration settings (teacher demonstrations). Successful learning of Chemistry depends partly on correct use of a teaching method whose activities target most learning senses. Since Chemistry is a subject that encourages „hands on" experiences, more practical oriented modes of instruction should be selected (Twoli,

2006). Practical are a very prominent feature of school science in many countries and a high proportion of lesson time is given to them.

Science practical is very much a characteristic of the school science curriculum. They have been part of school science curriculum for over a century, and their place in a Chemistry lesson has often gone unquestioned. For example, the West African Examinations Council (WAEC, 2017) syllabus had over the years recommended that the teaching of all science subjects listed in the syllabus should be practical based, and after several decades of emphasizing the assumed importance of practical in science teaching and learning, the importance became elevated to the level of a dogma (Abimbola, 2010). Similarly Hodson (2009,) argued that, “teachers have been socialized by the powerful, myth-making rhetoric of the science teaching profession that sees hands-on practical work in small groups as the universal panacea - the route to all learning goals and the educational solution to all learning problems." Like other sciences, Chemistry teaching and learning is supported by laboratory experiments (Reid and Shah, 2007). Chemistry practical classes (experiments) are believed to help students in understanding theories and chemical principles which are difficult or abstract.

Practical offers several opportunities to students such as: handling of chemicals safely and with confidence, acquiring hands-on experience in using instruments and apparatus, developing scientific thinking and enthusiasm to Chemistry, developing basic manipulative and problem solving skills, developing investigative skills, identifying chemical hazards and learning to assess and control risks associated with chemicals. However, Hofstein (2014) argued that research has failed to show a simplistic relationship between experiences provided to the students in the laboratory and learning

Chemistry. There are concerns about the effectiveness of laboratory work in helping the students understand the various aspects of scientific investigation. Teachers usually want to develop students' higher order thinking skills, like critical thinking, through laboratory work; but to what extent they can achieve this is controversial. Therefore, it is important to analyze the purposes related to laboratory work, as the purposes need to be well understood and defined by teachers and students alike for the Chemistry practicals to be effective.Traditionally, Chemistry courses at all levels have included instruction in laboratory settings where students follow procedures directing them to mix chemicals, make measurements, analyze data, and draw conclusions. At the elementary, secondary, and early college levels, Chemistry practicals frequently consists of what is generally described as "cook-book" exercises (Awad, 2014). The goals and desired outcomes of Chemistry practicals are the subject of considerable debate. Important aspects of the debate centered on the value versus cost of any laboratory experience and safety versus hazards of chemicals. Administrators cite these concerns to justify the elimination of Chemistry practicals all together (Hodson, 2009).

Reports of the Board of Directors of the National Science Teachers Association (NSTA, 1982) in the USA (Abimbola, 2010), recognized that there were widespread doubts about the importance of science practical in science teaching and learning in the seventies. For example, the national science education standard and other science education literature emphasize the importance of rethinking the role and practice of practical in Chemistry and science teaching in general. Likewise, the Ministry of Education in Singapore was examining the role that science practical played in science education and re-evaluating how school science practical could be made more

meaningful and productive for students (Ling and Towndrow, 2010). Teaching and learning of Chemistry can also be supported and improved through the use of information and communication technology (ICT). ICT is considered as a versatile source of scientific data, theoretical information and offers a viable means to support authentic learning in Chemistry (Awad, 2014). Prior to Internet being available, the only learning materials were textbooks, Chemistry laboratory facilities and equipment, and the only authority figures were teachers. However, (Awad, 2014) reports that there are so many learning materials such as html documents, e-books and electronic encyclopedias in the Internet and also many ways to get in touch with authority figures such as scientists and other school teachers. All what a student may want to know can be obtained through searching the Internet.

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

settings depicted in the video clips provided interesting and relevant contexts for students.

2.4.5 Conventional (Lecture) method

Teaching methods are patterns of teacher behavior that occur either simultaneously or in sequence in a verified way. Choosing specific teaching method that best achieves course objectives is one of the most important decisions a teacher faces. Knowing what methods are available and what objectives each method is best suited for, help teachers make this decision more easily. Conventional method is basically narration that will signify what we usually call explanation or description. A lecture is a narrative technique of delivering verbally a body of knowledge according to pre prepared scheme of action as cited by International Dictionary of Education (2009). According to it, in lecture method fact or principle is presented orally to groups of students who take notes, have little or no participation in learning, and experience passive rather than active learning." Lecture can be used to effectively survey the structure of knowledge in a particular area as well as suggest the connection between cases and real decision-making, reaching students at an emotional level, and provides necessary motivation for learning difficult material(Bimbola 2010). Good lectures have certain qualities that determine the effectiveness of the method. Lectures can be good or bad depending on these qualities. He further elaborated that one aspect of the lecture method which causes some concern is that its effectiveness is dependent on the skills of the individual lecturer. The ability to organize and explain a topic does not come naturally except to a fortunate few individuals. Virtually everyone who has education will have encountered poor lecturers, and will have seen the damage that they can do to their

students. Similarly, lecture method allows more material to be covered, in particular the multiple and varied exemplars that have been associated with superior acquisition and transfer. It is the most economical method of transmitting knowledge, but it does not necessarily hold the students' attention or permit active participation. However, lectures can be effective, if supported by texts and other references but it is significantly less common in primary and Secondary Schools. He opined that laboratory sessions are more effective in stimulating the students' interest and assessing their understanding of the material.

On the other hand, lectures also communicate the intrinsic interest of the subject matter. The speaker can convey personal enthusiasm in a way that no book or other media can. Enthusiasm stimulates interest and interested people tend to learn more. However, it may be kept in mind that only well prepared and well presented students welcome lectures. It cannot be used in teaching higher cognitive and effective processes such as attitude. As a means of teaching, it is suitable only for mature students and only in specific subjects. It can be used where the teacher does not require establishing each and every point in his lecture during instruction. But it is generally not suitable for younger students, as in teaching them the teacher must know that each point is understood before proceeding to the next. The value of lecture method depends on the specific objective of the teacher. If the teacher wishes to communicate information, the lecture method is reasonably efficient, but if the teacher desires to develop the power of critical thinking, problem solving ability and attitudinal change, the project method is superior. Teachers need several different kinds of knowledge i.e. knowledge about the subject matter, knowledge about curriculum goals; knowledge about the challenges

students are likely to encounter in learning these ideas; knowledge about how ideas can be represented effectively; and knowledge about how students' understanding can be assessed. The primary aim of every lecturer should be to make sure that they communicate effectively with their students. In order to do so, a lecturer should try to achieve clarity of delivery, clarity of expression and clarity of structure. The conventional method is one several teaching methods, though in schools it is usually considered the prime method of instruction.

This method of teaching pays more attention on teachers which in turn helps to decrease students learning interest to a greater extent. The conventional teaching method is mostly used for students in the tertiary institutions, where the material to be learned is given in a completed form to the learner. The teacher dishes out the information to the learners, and in most cases, the learners are passive recipients of the information. The conventional method therefore reverses the concept of education which maintains that the best learning is that which results from purposeful activity. Furthermore, anything which puts the students in a passive situation and stresses activity for the teacher rather than the learners is bound to benefit the teacher more than the students (Edwin, 2011).

2.4.6 Advantages and Disadvantages of Conventional Method

The conventional method has a few advantages that have kept it as the standard method to teaching for so long. Bellow according to Paris (2015) is a list of some advantages followed by descriptions of each.

1. **Teacher control**: In the situation of the teacher control, the lecture is delivered by one authoritative figure who is the teacher, professor, or instructor of some kind- that person has full reign of the direction of the lesson and the tone of the classroom. They

alone are able to shape the course, and so conventional method remains highly consistent when it comes to what kind of information is delivered, and how it is delivered.

2. **Presentation of many facts**: The conventional method is one of the most efficient teaching methods for presenting many facts and ideas in a relatively short period. Logically organized materials can be presented consciously in a rapid sequence.

3. **New materials:** Lectures are literally just long-winded explanations of information, deemed important by the teachers. As such, students can absorb large quantities of new materials.

4. **Instructing large group:** The conventional method is a method of instructing large group of learner. It welcomes the use of a public address system if possible to ensure that students hear the lecture. The conventional method is sometimes the only efficient method to use if the students number is high. The lecture allows a large number of students to receive information from real experts in a subject. In general, a person who can speak from actual experience or a scholar who has carefully analyzed the results of research will have great credibility with students. The conventional method is often the most effective way of communicating the energy and enthusiasm of a person who has actual experience in a field, thus, motivating students to learn.

5. **Introduction:** The conventional method is particularly suitable for introducing a subject. To ensure that all students have the necessary background knowledge to learn a subject, basic information can be presented in a lecture. By the lecture in this manner, students can be offered with varied backgrounds. A brief introductory lecture can give direction and purpose to a demonstration or prepare students for a discussion.

Many do not see the nature of the conventional method as helpful in the least, hence some of its disadvantages;

1. Instructors may have to spend much time preparing for lectures. With the demonstration-performance method of instruction, students participate actively. With the case study and guided discussion method, students participate verbally. The teaching interview relies heavily on the knowledge of an expert and provides for students involvement through a question-and –answer period. But, with conventional method, a greater burden for the total lesson rest on the instructor.

2. The conventional method does not make provision for participation by the students. As a result, many students willingly allow the instructor to do all the work. Learning is an active process, but the lecture method tends to foster passiveness and dependence on the instructor.

3. The conventional method does not lead to maximum achievement in certain types of learning. Speech skill, cooperative group thinking, and motor skills, for example, are difficult to teach with the conventional method. Students can develop such skills well only through practice.

4. The conventional method does not provide teacher with the opportunity to estimate students' progress before an examination. Within a single lecture period information may be presented to students than they can absorb and there is little or no accurate means of determining what they have learned.

5. The conventional method of teaching is not only seen as a biased one-way road, but also seen as a wholly passive experience for students. Not being engaged actively in a discussion over certain materials can make the material itself seem worthless to the

students. If students have no opportunity to interact with the course material with the person delivering the lecture, they will receive only a shallow understanding of the subject being taught. They might even be bored by the materials because they will have no opportunity to learn how the subject applies to them on a personal level.

2.5 Historical Perspective of Laboratory

The laboratory may be defined as a place equipped for experiment study. That is, the word laboratory to most people is synonymous with scientific investigation. Akinlogu and Tantogan, (2015) observed that there were no instruments designed for study of science before 1600. Before then, most of the scientific instruments found in the laboratories were borrowed from craft and craftsmen whose apparatus were found then to be superior to those used by the scientists of the period, inclusion of laboratory instructions as an integral part of science teaching. There was a tradition whereby famous community arranged demonstration lectures that usually attracted “men of culture”. Eminent pioneer scientists like Lavoisier, Priestly, Cavendish, Dalton and Berzelius converted their homes to laboratories where demonstration lectures were held on regular basis Daramola, in Abayomi (2010), the establishment of regular instruction in science teaching was credited to Liebeg (1803-1873) who made laboratory work available to postgraduate science. Nevertheless, other scientists recognized to have offered laboratory instruction in German Universities as early as the century included Stromeyer, Fucks and Fisher (Daramola, in Abayomi (2010), by the nineteenth century, the study of science had become worldwide and laboratory instruction was introduced in different parts of the world.

As stated by Bolorunduro in Abayomi (2010), some of the objectives of education for science are; to train minds for research investigation, discussion objectivity and intellectual adventure. This implies that students need exposure to laboratory work. Bolorundoro noted that the problem of inadequate facilities for individual or group work couple with the large classes would appear to have worsened. This issue demanded urgent attention from the authorities, agencies and institutions concerned. Equipment and materials have to be provided, teachers have to be well trained and studentsbe exposed to practical work in order to acquire the much desired practical skills.

Laboratory is where the students become involved with their environment in such a way that the theories and principles encountered and discussed during the lecture can have a meaning. Bolorunduro explained that one of the laboratory functions is to provide the students with required skills to stimulate their knowledge. Laboratory is a place where knowledge is discovered when these are not available, teaching and learning becomes too theoretical to have desired impact on students as well as give lectures satisfactions.

2.5.1 Importance of Laboratory Work

A deeper understanding of the science and technology processes can be achieved through laboratory activity, which gives active participation and serve to develop critical thinking. They provide concrete experiences to substantiate the theoretical aspect that has been taught. In adopting laboratory based methods, a teacher is expected to organize and structure instructional materials, experiments subtly direct the activities so as to stimulate the learners and contribute towards meaningful understanding of the subject

being taught. These activities are not necessarily only class experiment and demonstration but they include those activities that provide practice in designing experiments, operating and interpreting data and thus lead to acquisition of suitable scientific attitudes (Raimi, 2012).

The laboratory has now become a forum where both the Chemistry teachers and their students interact with materials under controlled conditions as they investigate nature in seeking answers to many problems and finding out scientific facts and information (STAN, 2000). Both teachers and students of Chemistry have found the laboratory a unique place to carry out their "wise guesses" and hypotheses through experimentation.

In Chemistry learning and teaching some skills demanded are:

(i) ability to plan an experiment to solve a problem,

(ii) ability to carry out the experiment,

(iii) ability to gather information (result) from the experiment,

(iv) ability to interpret the result obtained and draws conclusions, and

(v) ability to present the result to others (communication).

These processes can only be developed and acquired as students are allowed to participate in Chemistry instruction through laboratory work. Therefore, a Chemistry teacher must be aware of common dangers and take wise precautions to prevent or limit the occurrences of these dangers (Raimi, 2012).

2.5.2 Goals and Objectives of Laboratory Activities

A number of objectives have suggested justifying actively based methods in the Chemistry. These suggest that appropriate activities not only help instill appreciation of

the subject concerned but also motivate learners towards a better achievement. Activities provide experiences which are essential to the better understanding of physical principles. Laboratory activities exercises in solving problems based upon real physical situations and also an appreciation of the various methods used in experiences such as Biology, Chemistry, physic and so on such methods include understanding competence in the use of apparatus. Training is precision and an awareness of the problems involved in precise laboratory work. These methods help learners to definitions of concepts; formulate relevant questions and theories relating to any assumptions and arguments used in the experimental process (Omosewo, 2012).

Besides content achievement and cognitive development the activities succinctly needed to develop skills in scientific thinking consists of more than mere deduction and induction but also involves generalizing operations and logical thinking with learner's abilities in: identifying problems and questions; categorizing of attribute through observations, comparison of differences and similarities; measuring Qualities; manipulating of materials and data formulating of hypothesis and laws, and making conclusion/decisions based on established fact.

These abilities often stimulate the transfer of learning from one problem to another and to other relevant life situation are other benefits that can be derived from laboratory activities. According to Omosewo (2012), such include: training for competence which readily can be transferred to other learning situations; development of skills, including motor skills; acquisition of desirable attitudes including respect for truth, accuracy and appropriate attention to details; and ability to investigate variables and work on effective ones.

Consequently, laboratory teaching assumes that first-hand experience in observation and manipulation of the materials is superior to other methods of developing understanding and appreciation. Laboratory training is a frequently used skill necessary for more advanced study of research. Hence it is hard to imagine learning about Chemistry without doing laboratory of field work. Experimentation underlines all scientific understanding; laboratories are wonderful settings for teaching and learning Chemistry. They provide students opportunities to think about, discuss and solve real problems.

Laboratory Method of Teaching

This is an activity carried out by one or more persons through the exercise and experimental approaches. Laboratory exercises are activities carried out in order to provide practice in designing, operating, and interpreting experiments. Experiments are operations or procedures employed for the purposes of testing a hypothesis or supposition, confirming the known and discovering the unknown. Himanshu, (2012) described laboratory methods as one of the important methods of teaching science and it forms an integral part of effective science teaching. Under this method; teachers encourages the students to derive various scientific laws and principle on their own by getting personally involved in the experimental work. For this, provision of a well-equipped laboratory is made by the teacher. Along with such materials and facilities, proper instructions are being provided by the teacher to the students by which they can carry out their experiments self-independently. They carry on the experiments and record the observation properly on the basis of which they enter their results or draw conclusion. For science teaching, this method is used to maximize possible extent by the

teachers, as a result of which some experts have divided it into various categories some of which are as follows:

Inductive Laboratory Method: - Through this method, students get the opportunity to form various scientific concepts and principles on their own as in this method they have to take part in various laboratory functions. Therefore, laboratory methods assume that first-hand experience in observation and manipulation of the material of science is superior to other methods of developing understanding and appreciation (Omosewo, 2012).

There are two major types of laboratory teaching method. A situation where the students work in the laboratory and the other type is where one person demonstrates. But there is certainly no substitute for an instructor circulating among the students answering and asking questions, pointing out subtle details or possible applications and generally guiding students' learning.

Situation where Students work in the Laboratory: - In this situation student's work in pairs or groups where equipment cannot go round all students individually. In many laboratories some teachers may introduce cooperative learning into their work. This type of learning strategy improves students' academic performance. Some instructors rely on a laboratory handout, not to give cookbook instructions but to pose a carefully constructed sequence of questions to help students design experiments which illustrate important concepts. One of the advantages of the well-designed handbook is that the designer, closer controls what students do in the laboratory. The challenge is to design it so that students must think and be creative. In more instructed laboratories the teacher or instructor should prevent students from getting stranded and discouraged.

Therefore, any access to teachers or teaching assistant is essential in this type of laboratories.

Advantages of Laboratory Method

The following kinds of merits can be accruing by making use of laboratory method: According to Yusuf, (2012), such include: -

(1) laboratory method makes the students learn about the nature of science and technology thereby enhancing the students' interest and sharpening their understanding,

(2) laboratory method enhances the ability of students to transfer skills to solve other problems,

(3) laboratory method has the potential of stimulating interest in science among students. Through laboratory method, students develop scientific attitude and character which includes: curiosity, open mindedness, objectivity, honesty, reverence for life, rationality etc.,

(4) it affords the students' opportunity to develop manipulative skills through several attempts and trials in the laboratory,

(5) laboratory method gives students opportunities to gain exposure to facts of scientific phenomena which aid retention of information,

(6) getting results in laboratory sharpens the students' mind and enhances the development of self-confident,

(7) laboratory method increases students' ability for critical thinking, acquisition of improved understanding of basic concepts, principles and facts of science.

Disadvantages of Laboratory Method

The following kinds of demerits can be attributed by making use of laboratory method: According to Yusuf, (2012), such include: -

1. it is an expensive method: Equipment and materials are quite expensive,
2. danger or accident in inherent,
3. takes much of the students' and teachers' time i.e. it consume time.

Challenges of Laboratory Method of Teaching

Security

As stated by Aina (2013), security issue in Nigeria has been worrisome for more than two years now because of insurgence of "Boko Haram" as averred by Horstall. People in Nigeria live in fear of uncertainty of death from bomb explosion, gunshot from terrorist or armed robbers and many a time from kidnappers. The recent attacked on a northern university where students and lecturers were cold bloodedly murdered including a Professor of Chemistry still remains an insomnia in academic arena. Science infrastructures built with high amount of money for schools had been destroyed. Schools were closed down in many parts of the country; universities, polytechnics, Colleges of Education, secondary and primary schools where learning environment are no longer safe for learning remain in long compulsory holiday for months. Posited that anywhere students were not able to attend schools regularly for fear of bomb explosion or kidnapping will not be able to interact socially and this will affect their learning e.g. Chibok girls that were kidnapped since April, 2013, nothing has been done. These also affect the academic performance of students in Chemistry.

Teachers

Aina, (2013), described Chemistry teachers as key factors to be considered when talking about the development of Chemistry education in any nation. There are shortages of qualified Chemistry teachers in Nigerian schools. Some Chemistry teachers are not professionally qualified. They may have the knowledge of the subject but lack the method. Attitude of many Chemistry teachers to teaching are discouraging; they have been teaching for many years without upgrading their certificate by going for in-service training. This affects their output and it is a problem to the development of Chemistry education. Science teachers should use different strategies as there is no single universal approach for specific class. Many Chemistry teachers still hold to chalk and talk method which is not appropriate for science teaching. Lack of good strategies in the teaching of Chemistry is affecting students' performance and at long run affects student's enrolment.

2.5.3 Improving Chemistry through practical activities in the laboratory

Chemistry is an experimental science. The laboratory is an ideal environment for both active and cooperative learning (Hass in Kwabena 2013). Active engagement in laboratory exercises promotes a thorough understanding of the concepts described in lectures. A further enhancement of the laboratory experience can be gained by encouraging students to interact with each other during the practical activity process. Experiments or laboratory work are very important for students not only for understanding Chemistry but also for increasing the students' ability to solve problems.

Laboratory work is time consuming and expensive compared to other models of instruction. Hence, the efficiency of such a method of learning should justify the

additional time and cost of using it. In other words, the increase in the educational budget for using laboratories as a model of teaching should be more efficient in accomplishing the objectives of teaching sciences than other models of instruction (Kwabena 2013).Teaching Chemistry through laboratories need therefore, be constantly evaluated using one or more of the following methods (Kwabena 2013). The teamwork learning laboratory will be more focused on research work and designing laboratory activities and requires more collaboration between students and the development of teamwork. Teamwork learning methods also require students to have more imagination, more planning and to accept more challenging tasks. It places more emphasis on active learning and extra skills development. Before the laboratory session, students need to plan and design the detailed laboratory steps. During the laboratory session, they need to check their plan and design and revise the laboratory project. After the laboratory session, they need to analyse the data and experimental phenomena and write the experiment reports (Musa, 2010). Students need to be encouraged to become deeply involved in the laboratory work so as to develop their skills. This is because a research study on students' knowledge retention showed that students usually retain 10% of what they read; 26% of what they hear; 30% of what they see; 50% of what they see and hear; 70% of what they say; 90% of something they say while they are doing a task Lagowski in (Kwabena, 2013).

2.5.4 Importance of Laboratory Activities in Learning Chemistry

Laboratory practical like fieldwork, are by their very definition and operation totally active and interactive ways to teach and learn, and considered as valuable tools in maximizing the learning experiences of both students and staff. The combination of

classroom based theory and the application of these theories in the laboratory are considered by many not only as essential components for the modern, successful Chemistry graduates and future research chemists but are also important in the promotion and development of indispensable, generic skills needed for non- Chemistry related career opportunities. The value of laboratory led education is not only recognized by the academic and private sector but is also highly valued by students themselves, who appreciate the opportunities, contextualization and challenges that laboratory practical offer.

Having a distinctive role in Chemistry curriculum, laboratory activities and experiences are crucial for Chemistry learners to comprehend concepts, acquire scientific and problem solving skills, scientific habits of mind. Since Chemistry is an experimental branch of science, laboratory is the only place that is capable of developing students' scientific processing skills. Laboratory applications should include activities which allow students to make choices with exploratory actions. They should be learner-centered, comprise before and after experiment studies, exciting experiments that are connected with real-life rather than boring experiments (Feyzioglu in Kwabena 2013). In their paper about studies on laboratory applications in several countries, Muhammad (2014) reported that laboratory applications aim at developing students' scientific processing skills, problem solving skills, and draw their attention and develop positive attitudes towards scientific approaches according to objectives of fundamental Chemistry education. Garnett, Garnett and Hackling in Kwabena (2013), mentioned that the laboratory helps students develop their conceptual understandings, application skills and techniques, interrelations among variables and analyzing skills for chemical analysis

and synthesis. They also implied that in order to develop students' research skills which include problem analysis, planning and conducting research, data collection and interpreting findings; laboratory approaches that enable learners active participants need to be followed. Science educators suggest laboratory applications which lead learners to explore and inquire (Kwabena 2013).

All science curricula in Nigeria lists practical activities that should go with each topic item listed. The current West African Examinations Council (WAEC) syllabus (WAEC, 1988) in use in 1996, recommended that the teaching of all science subjects listed in the syllabus should be practical based, perhaps, to demonstrate the importance it attached to practical work in science. Thomas, White and Tisher in Kwabena (2013) are of this opinion. This position is, perhaps, why Yusuf (2013) said, "All science teachers and students know that practical work is the 'gem' of science teaching".

According to Akinleye (2010) science laboratory works are the factors that contribute to students' achievement. Likewise, the findings of the Adeyegbe (2013) indicated that laboratory adequacy affected the performance of students in Chemistry. Furthermore, Akpan (2009) also indicated that the effective use of the science laboratory may have a significant effect on students' performance.

According to Kwabena (2013), students tend to understand and recall what they see more than what they hear because of using laboratories in the teaching and learning of science. However, the findings of (Bryce and Robertson; Lunetta in Yusuf (2013) concluded that laboratory experience has relationship with students learning outcomes.

According to Addison and Wesley (2012), the laboratory "gives the students appreciation of the spirit and method of science, it promotes problem-solving, analytic and generalization ability. It provides students with some understanding of the nature of science". Some other review of the literature revealed the following goals for laboratory instruction in Chemistry education (Kwabena, 2013). The goals are;

a. to arouse and maintain interest, attitude and curiosity in Chemistry.

b. to develop creative thinking and problem solving ability.

c. to promote aspects of scientific thinking and the scientific method.

d. to develop conceptual understanding

e. to develop practical abilities.

2.6 Discussion method in Chemistry Teaching

Discussion method of teaching involves a group of people in a class who come together to exchange ideas, facts, opinions and expression orally about topic of mutual concern and interest under a guide (Wilkinson, 2009). Discussion is one of the most widely used and valuable method in the teaching of social studies. It represents a type of teamwork, based on the principle that the knowledge, ideas, and feelings of several members have great merit than those of a single individual. In a discussion class the students are actively involved in processing information and ideas. Since student-initiated questions are more common in discussion classes, their needs and interests are dealt with more readily and spontaneously than in other methods.

Discussion is a forum in which students can practice expressing themselves clearly and accurately, hearing the variety of forms that expression of the same idea can take, and criticizing and evaluating successive approximations to an adequate Statement.

Discussion is used to arrive at the solution of problems and is characteristics of democratic societies. It occurs in a group form and usually involves six to ten persons. These persons perform one of two roles: leader-moderator who is typically the teacher, and participant: typically the students. Participants use the time to communicate with each other. Another student follows the group leader addresses their remark to the whole group and each group member has the right to speak. A group member communicates with other members in the group by speech, and by facial expressions, gestures and body movement. Other members receive the message by listening and by seeing the non-verbal signs. These processes of listening, speaking, and observing are the bases of discussion method. In a discussion class, the students talk to each other about the concept or problem until there is an agreeable understanding to it mentally. This method encourages the learners to be independent of the teacher and discover knowledge and also see relationships on their own. As a teaching method, discussion encourages learning through active involvement of students in the lesson.

Discussion offer students with a chance to express opinions and exchange information safely within the classroom. Discussion takes place after the facilitator has provided materials through a lecture, digital media, or reading (Wilkinson, 2009). Apparently, the discussion class is intended to be a free give and take between teacher and students and among students on the current topic of concern in the course. Discussion is characterized by probing questions from the teacher designed to elicit students' interpretations, opinions and questions. Petty and Jenson in Rahman, Khalil, Jumani, Ajmal, Malik and Sharif (2011) have added that students learn to deal with facts through discussion method. Discussion is the thought of taking a problem and

investigating all options with ultimate objectives to reach a mutual understanding of the problem. Teaching by discussion can be effective means of helping students apply abstract ideas and think critically about what they are learning. It is important to be clear about the objectives of holding the discussion and how it fits into the overall course. Discussion is one of the most widely and valuable method in the teaching of Chemistry. It presents a type of teamwork, based on the principle that the knowledge, ideas, and feelings of several members have great merit than those of a single individual. Lowman cited in Rahman et al (2011) highlighted this view point that two types of teacher-students interchange are sometimes called discussion. In one, the teacher gives students an opportunity to clarify content or ask for opinions on related topic. In the other, the teacher asks questions requiring specific knowledge of course content.

In a discussion class the students are actively involved in processing information and ideas. Since student-initiated questions are more common in discussion classes, their needs and interests are dealt with more readily and spontaneously than in other methods as pointed out by Gage and Berliner cited in Rahman et al (2011) that, discussion is a forum in which students can practice expressing themselves clearly and accurately, hearing the variety of forms that expression of the same idea can take, and criticizing and evaluating successive approximations to an adequate Statement. Hyman cited in Rahman et al. (2011) highlighted that discussion is used to arrive at the solution of problems and is characteristics of democratic societies. It occurs in a group form and usually involves six to ten persons. These persons perform one of two roles: leader-moderator who is typically the teacher, and participant: typically the students.

Participants use the time to communicate with each other. Another student follows the group leader addresses his/her remark to the whole group and each group member has the right to speak. A group member communicates with other members in the group by speech, and by facial expressions, gestures and body movement. Other members receive their message by listening and by seeing the non-verbal signs. These processes of listening, speaking, and observing are the bases of discussion method (Vedanayagam, cited in Rahman et al., 2011). Discussion is thought to be a useful teaching method for developing higher-order thinking skills; skills that enable students to interpret, analyse, and manipulate information. Students explain their ideas and thoughts, rather than merely recounting or reciting memorized facts and details. During discussion, learners are not passive recipients of information that is transmitted from a teacher. Rather, learners are active participants. As they interact during the discussion, students construct an understanding about the topic (Johnston, Anderman, Milne & Harris, Tharp & Gallimore, cited in Larson, 2010). For discussions to educate students there should be serious interactions where students support their ideas with evidence, where their opinions are subject to challenge by their peers as well as the teacher, and where the teacher's ideas are equally open to criticisms (Engle & Ochoa, cited in Larson, 2010). The purpose of probing questions and discrepant viewpoints is to encourage interactions and to encourage students to respond with the most powerful evidence available to them. The very process of discussing a topic may facilitate abstract learning processes (Bridges cited in Larson, 2010). Bridges suggested that discussions contributed to discussants' understanding of a topic by expanding each discussant's information on a topic with information from other discussants; fostering different

perspectives on a topic; providing opportunities for discussants to present alternative ideas about a topic; providing opportunities for other discussants to criticize, accept, or refute these alternative ideas; and encouraging mutual modifications among discussants' opinions to produce a group decision or consensus. Group interaction is the important component for each of these as it shapes and directs the exploration of a topic. Discussion method requires students to be active, responsible participants in their own learning. When a classroom operates with this method, students and instructors share the focus instead of listening to the teacher exclusively, student-teacher interaction is encouraged and students learn to collaborate and communicate with one another.

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2.6.1 Types of Discussion

Discussion method refers to a particular kind of instruction in which the teacher leads the students into active participatory learning activities in the classroom. Problem is initiated in order for the students to interact with each other and find solution to the problems. Discussion method can be grouped into many types depending on the objectives on the discussion class, number of the students involved and their abilities (Abubakar and Dantani, 2007). The discussion group may be in three forms that is, the whole class, small group or the panel (NTI, 2013), while Nacin and Brown in Efe (2015), added that the discussion method can be grouped under four main headings namely: Whole class discussion; small group discussion; panel discussion; and debate discussion.

i. Whole class discussion: This type of discussion involves the whole class when the class is at its normal size that is, between 30-35. It is usually used when the students

are inexperience to handle any organized discussion on their own. The success of it is left entirely to the teacher who in this case serves the role of a chairman, thus directs and guides the discussion. In other words, the teacher initiates the interaction and directs the discussion among the participants through posing the problem or the issue that needs to be discussed. The discussion is concluded by the teacher summarizing the main points made.

ii. Small group discussion: This type of discussion consist of small group of about five to six students, NTI (2013) added that this type of discussion is ideal for meaningful learning since small group is better than the large group. In this method, students will have more opportunities to contribute to the discussion. Teacher's role in this type of discussion is just to supervise and monitor the conduct and progress of every group. Students' participation is more in the learning process; they listen to opinions of others and express theirs too. Learning is more effective because they learn on their own, discover key area to note and exchange ideas too. The teacher, after the students' presentation corrects their mistakes and errors.

iii. Panel Discussion: This type of discussion involves a group of five to six students, selected to address the class on different aspects of topic. Time limit will be given to every member of the panel base on the topic assign to him/her to discuss about while the class jots down points made as the members of the panel speak one after the other. At the end of the presentation, the topic is thrown open to the class for comments while the moderator or teacher summarizes the points and dawn conclusion.

iv. Debate discussion: It is a discussion or structured contest about an issue or a resolution. Effeh (2015) viewed debate type of discussion method to involve two groups

of learners who will take for or against the motion to their learning of the audience which includes their classmates. In other words, debate can be defined as a formal discussion that expresses different opinions on issues of common interest at a public gathering. Thus, debate can be seen as a formal interactive communication where different opinions of the speakers were expressed in form of proposing or opposing a motion. Topics for the debate are not treated in the class. However, teachers modify the presentation at the end of the speaker's final presentation.

2.6.2 Task in Discussion

The main feature of the discussion is the increase involvement and active participation of students in learning activities. It is a student centered method and is based on the philosophy that "knowledge arises within the person and not from any external source (Nigerian Journal of Teacher Education and Teachers, 2012). Thus, several tasks involved in a discussion which according to Mezieobi and Fubara (2008) consist the following:

1. Ensure that he has a fair grasp of the subject or topic of discussion
2. Topic for discussion must not only be interested to attract the attention and interest of the students, they must be relevant to the students' needs. In other words, it must be tailored to the ability level of the students
3. For effective participation of the members of the discussion group and for a meaningful discussion each member must be informed about the topic so as to prepare for it. Hence, effective participation in the discussion entails that the group has pre- requisite knowledge of the topic under discussion group and for a meaningful discussion; each member must be informed about the topic so as to

prepare for it. Hence, effective participation in the discussion entails that the group has pre-requisite knowledge of the topic under discussion.

4. The topic must be clearly defines by the leader.
5. Ensured that the topic is within the confined of the topics being discussed.
6. If the discussion digresses from the topic, the study should be courteously brought back to the discussion in such a way that he does not take offence and create a scene through quarrelling or fighting which may disrupt the discussion or disorganized the group.
7. If the discussion is tending toward wrong conclusion, the leader should make an input by clarifying issues or by asking leading questions that would bring discussion into thinking along the right direction.
8. At the close of the discussion, conclusion should be re-Stated in order to acquaint the participation and discussant with the decision of the discussion groups in the case of doubts.

2.6.3 Procedure for Planning and using Discussion

The following steps need to be adhered to whenever discussion is to be used in a teaching and learning situation.

1. Teacher to select a topic: issue or problems that apply to real life situation and generate students' interest.
2. Seat should be arranged in a convenient manner for the student, to face each other.

3. The discussion atmosphere should be students' friendly and democratic for the students to learn and respect the opinion of one another. Differences in opinions must be tolerated and amicably resolved.
4. Teachers to group select and appoint a secretary in case group and panel discussion.
5. The teacher guides and monitors the discussion
6. Point raised by the discussants is summarized by the teacher at the tail end of the discussion.

Discussion is the process of giving and taking, speaking and listening, describing and witnessing which helps to expand horizons and foster mutual understanding. They further explained that, it is only through discussion that one can be explored to new point of view and exposure, increase understanding and renew, motivation to continue learning. Dillion in Orji (2016), emphasized that discussion is highly "discipline and concerted" in which people come together to resolve some issues or problems that are important to them. Thus, discussion method is a process by which learners acquire skill by way of affiliating with one another and make a participatory lesson contact possible and interactive. Islamic studies teachers should employ discussionmethod topromote this skill in secondary school students as it goes a long way in improving their performance and retention.

Kocchar (2016) viewed a process of discussion to be a collective decision making that involves the use of the following process: Lying plans for work; and making decision concerning future work;

2.7 Retention of Learned Chemistry Concept

Retention is the ability of an individual to remember things. Permanent and meaningful learning are the ultimate target of any educational endeavor. Ausubel in Daniel (2015) ascertained that learners should be actively involved in the classroom activities to foster meaningful learning by prompting the students regarding pre-existing super-ordinate concepts into which the students can incorporate progressively differentiated details. Active involvement in a lesson by learners is therefore, a cognitive strategy to promote rapid learning and retention of concepts. It is a means of preparing the learners' cognitive structure and provides a structure for students' thinking (Long-Crowell, 2014). According to Daniel (2015), content is usually presented ahead of a learning task at a higher level of abstraction, generality and inclusiveness to strengthen the learners' cognitive structure. Therefore, the active participation influences students' prior knowledge on meaningful learning. Lin and Cheng (2016) had in separate studies shown that the use of appropriate teaching methods improve students' understanding and retention of science concepts due to the way the organizers provide retention and scaffolding of new ideas with preexisting schema. Hendron (2014) submitted that advance organizers improve levels of understanding and recall and that higher level or more abstract organizers produce deeper learning than lower level or more concrete advance organizers.

Oloyede (2011) and Atomatofa (2013) demonstrated that pictorial advance organizer was most facilitating followed by written organizer and non organizer was least in enhancing students' retention of learned concepts. Novak (2009) agreed that approaches that have remarkable capacity for acquiring and retaining visual images such as graphics organizers significantly enhance the learning capability and retention of all

learners. Novak, (2009) submitted that graphics organizer is a simple tool that facilitates meaningful learning and the creation of powerful knowledge framework that not only permit utilization of knowledge in new contexts but also the retention of the new knowledge for long periods of time. Meaningful learning is possible if students are given opportunities to manipulate equipment and materials in an environment suitable for them to construct their knowledge of phenomena and related scientific concepts. Hendron, (2014) explained meaningful learning in terms of retention and emphasized that retention is a term used to denote the demonstration that learning has been maintained over time and may be displayed through recognition or recall. Hendron (2014) observed that recall or recognition is enhanced by presenting information in both visual and verbal forms.

2.8 Review ofEmpirical Studies

Previous empirical studies related to the effects of laboratory and discussion, methods were reviewed as follows:

Abdu-Raheem, (2011), investigated the effectiveness of discussion method of teaching on students' achievement and retention in Social Studies in Ekiti State. The study was carried out with four research objectives among which were to determine the difference between the achievement mean scores of students in the experimental and control groups; and to find out the difference between the pre-test mean scores and achievement mean scores of students in the experimental and control groups. The study adopted quasi-experimental, pre-test, post-test control group research design. The sample for the study consisted of 240 Junior Secondary School Class II Students. Simple random sampling was used to select 40 students each from six (6) Secondary Schools in Ekiti State, Nigeria. The instrument used for the study was the Social Studies Achievement

Test (SSAT). Four hypotheses were formulated and tested at 0.05 level of significance. The data were analyzed using t-test and ANCOVA statistical tools. The result indicated among others that there was a significant difference between the pre-test and achievement mean scores of students in the experimental and control groups. On the basis of the findings, it was concluded that discussion method was better than the conventional lecture method in improving students' achievement and retention in Social Studies. It was therefore, recommended that the teachers of Social Studies should always use discussion method to impart knowledge to students to enable them participate actively in the lessons, interact with instructional materials and colleagues. The principals should create an enabling situation for the teaching of Social Studies in schools and the government should enforce through supervision the use of discussion method to teach Social Studies in schools. The government should also organize on-the-job trainings, workshops, seminars, symposia and conferences at intervals for the teachers of Social Studies in Secondary Schools to update their knowledge on the application of the discussion method of teaching the subject.

The similarities of the previous research to the present study is that, each of the two studies had discussion as one of the teaching method examined, and both studies adopted quasi-experimental research design. Despite these similarities, the two studies differ as the previous study was conducted with four research objectives, while the present study was carried out with six research objectives. Also, the previous study used the Junior Secondary School class II students as respondents in Social studies subject in Ekiti State while the present study used the SeniorSecondary School class II students as respondents in Chemistry subject in Kaduna State.

Rahman, Khalil, Jumani, Ajmal, Malik and Sharif (2011), carried out a study on the "Impact of discussion method on the students' performance in Social Studies in Pakistan." The objective of the study was to assess the impact of discussion and lecture method on students' performance in social studies. The experimental research design was used. The Social Studies Achievement Test was used as instrument for data collection. Four lessons were selected in the subject of social studies and the duration of each period was 45minutes. The sample of the study was made up of 62 students of grade 10^{th}. The students were grouped into control and experimental groups equally. The two groups were pre-tested using the two teaching methods which were discussion and lecture methods. The data that were collected were analyzed using t-test. The result of the studies indicated that the mean score of the experimental group was higher than the control group. Major finding revealed that the discussion method was more effective than the lecture method. The study therefore recommends that teachers may prefer discussion method over the lecture method in teaching of social studies in Junior Secondary Schools.

The similarities between the reviewed studies with the present study are that both studies had discussion as a teaching method on students' performance. Both studies adopted the same research design (Quasi experimental). The differences that exist between both studies are that, the previous study was conducted using discussion method only while the present study was on laboratory and discussion methods. While the previous study was conducted in Pakistan, the present study was in Kaduna State, Nigeria. Ogbeba, (2013) conducted a study titled Comparative effects of the laboratory and discussion methods on Senior Secondary students' achievement in

Chemistry in Benue State. The study was conducted with three research objectives, which are to: determine the mean achievement scores of Chemistry students taught using the laboratory method and those taught using the discussion method; ascertain the difference in the mean achievement scores of students taught using the laboratory method with small class sizes and those with large class sizes; and find out the difference in the mean achievement scores of students taught using the discussion method with small class sizes and those with large class sizes. Also, three corresponding research questions and three hypotheses guided the study. A sample of 196 students out of a population of 1,924, SS II students from zone B of Benue State, Nigeria was used for the study. A validated 30 item Chemistry Achievement Test (CAT) was the instrument used to collect data. Reliability coefficients of 0.78 and 0.68 were established using Kuder-Richardson (KR – 21) formula. Mean (M) and Standard Deviation (SD) scores were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The results indicated that students taught using the laboratory method achieved significantly higher than those taught using discussion method (1,195 = 31.90), P<0.05. The study further revealed that students taught using both laboratory and discussion methods achieved significantly higher with a small class size in terms of students population than those with a large class size F(1,97) = 166.66,P< 0.05 and F(1,97) = 79.89, P<0.05 respectively. The study therefore, recommended among others that laboratory method should be used in teaching Chemistry and small class sizes (40 students) is being advocated for all schools‘ offering Chemistry instead of large (populated) classes.

The similarities between the studies is that both had laboratory and discussion as their teaching methods on students performance, they are also similar in the area of teaching subject (Chemistry), also, both study adopted the same research design and had same class level of respondents. The two studies differed in location, while the previous study was carried out in Benue State, the present study was carried out in Kaduna State. The previous study was conducted with three research objectives, while the present study was carried out with six research objectives.

Goje (2014) investigated the effects of laboratory teaching and lecture methods on academic achievement and attitude to acid and base concepts in Chemistry among the SeniorSecondary School students, in Kaduna State. The design of the study involved pre-test, post-test quasi-experimental and control groups. The population of the study is 650, comprising of all the Senior Secondary II Chemistry Students in Public Co-educational Secondary Schools in Kaduna State. The schools were sampled out using simple random sampling, where the selection of numbers at random was used by a table of random numbers, and the sample size was 146 students. Acid Base achievement Test (ABAT) was the instrument used for data collection. The instrument was validated by experts in the Department of Science Education, Ahmadu Bello University Zaria with reliability coefficient of 0.70. The hypotheses were analyzed using t-test statistics. The finding revealed that students taught with laboratory method performed "academically better than those taught with traditional lecture method. It was recommended that Chemistry teachers should employ laboratory strategy in the teaching and learning of Chemistry.

The reviewed study is related to the present study as both studies investigated the effects of laboratory method on performance of students. Both studies employed quasi-experimental research design on SeniorSecondary School II Chemistry Students. Finally, both studies were conducted in Kaduna State, Nigeria. In spite of the similarities between both studies, they differ in the population of students examined. While the reviewed study had a population of 650 Chemistry students, the present study had a population of 18,138 Chemistry students. The sample size of the reviewed study was 146 while the present study had a sample size of 207 Chemistry students. In the reviewed study, the attitude of students was considered as a variable while the present study did not review students' attitude.

Alabi and Lasisi (2015) investigated the effects of guided discovery and problem solving instructional strategies on achievement of Secondary School Chemistry students in Volumetric Analysis in Minna Metropolis, Niger State. Two research questions and one research hypothesis were tested at alpha level 0.05 of significance. Factorial design was adopted for the study. The population consisted of SeniorSecondary School two (SSSII) Chemistry students with sample size of 238 students selected from six Secondary Schools in Minna Metropolis. The research instrument employed was a 24-item Chemistry Achievement Test (CAT) developed from Volumetric Analysis and was validated by six experts in the subject area. The CAT was pilot tested on intact class of Chemistry students and reliability of 0.88 was obtained using Kuder Richardson (K-R21). Students were pretested before the treatment began, and the reshuffled or disguised version of the CAT was administered after the treatment in the post-test.

The data obtained from both pre-test and post-test were analyzed statistically using descriptive statistics (mean, standard deviation) and inferential statistics (Analysis of covariance, ANCOVA) using Statistical Package for Social Sciences (SPSS) version 20. The results showed that students in the experimental groups (guided discovery and problem solving) generally had higher mean achievement scores in Chemistry than their counterparts taught Chemistry with conventional teaching method (control group), and this indicates that guided discovery and problem solving strategies have enhanced achievements in Chemistry more than traditional method of teaching. ANCOVA test also revealed that there was a significant difference among the students taught Chemistry using the three instructional strategies, and Scheffe post hoc test indicated that students in the guided discovery group achieved better. The hierarchical order of achievement of Chemistry students' vis-à-vis the instructional strategies considered in this work is established as: Guided Discovery > Problem Solving > Conventional teaching Method. It is concluded that guided discovery and problem solving strategies are more effective in enhancing students' achievements in Chemistry than the convention teaching method.

Thus, it is recommended that teachers should expose Chemistry students to guided discovery and problem solving instructional strategies that promote and encouraged social interaction, active learning and ultimately enhance achievement. The stakeholders in education sectors should also encourage and enforce the use of guided discovery and problem solving instructional strategies in teaching and learning of Chemistry in particular and sciences in general in our Secondary Schools.

Both the reviewed and current studies had the same focus that was directed towards SSII as respondents of the instrument. They are also similar in the subject area examined which was Chemistry. However, the area of differences is that the reviewed study used the factorial research design while the current study used the quasi experimental research design. Also, the reviewed study was carried out in Niger State while the current study was carried out in Kaduna State.

Another study of interest was conducted by Isuwa, Dauda and Abubakar (2015), on the Effect of Computer Assisted Instruction and Discussion method on the academic performance of Agricultural Science students in SeniorSecondary Schools in Nasarawa State. The study was carried out with the objectives to: determine the difference between the academic performance of Agricultural Science students in computer-assisted instruction and discussion method; and determine the difference between academic performance of male and female agricultural science students in computer-assisted instruction and discussion method. Pre-test. Post-test quasi-experimental research design was adopted for the study. Three schools were randomly selected and from each school, one SSII class was selected. One hundred and twenty participants were selected from the three classes using random sampling method. A twenty five (25) item Achievement Test in Agricultural Science (ATAS) was administered to the two groups before and after the treatment. The data obtained were analysed with mean, standard deviation and t-test. The findings revealed that, students taught with computer-assisted instruction performed better than those taught with conventional discussion method and there was no significant difference between male and female performance in both computer-assisted instruction and discussion method. The researcher recommended that, Agricultural

teachers should deliver their lessons using computer-assisted instruction to facilitate better understanding and easy recalling of the topics taught.

The similarity of the previous research to the present study is that, both studies adopted quasi-experimental research design and the use of t-test for data analysis. Also, both studied had discussion as a teaching method examined, and examined students' performance at the SSII class level in SeniorSecondary Schools. The differences that existed is that, the previous study was carried out to determine the effect of Computer Assisted Instruction and Discussion method, while the present study was carried out to evaluate the effects of laboratory and discussion methods. Both studies differed in the subject area as well, while the reviewed study was in Agricultural Science, the present study was carried out in Chemistry. Also, the reviewed study was conducted in Nasarawa State while the present study was conducted in Kaduna State.

Olubu (2015) carried out a study on the effect of Laboratory learning environment on students learning outcome in Secondary School Chemistry in Ondo State. The objective of the study was to determine the effects of laboratory learning environment on students' learning outcomes in Secondary School Chemistry. The study adopted the pre-test - post-test, quasi - experimental control group design. The sample comprised 293 Senior Secondary III Chemistry students in their intact classes from six schools purposively selected from six Local Government Areas (LGAs) of Ondo State. Two research instruments were used for collection of data, namely: Chemistry Practical Achievement Test (CPAT) and Chemistry Attitude Scale (CAS). Data collected were analyzed using Analysis of Covariance (ANCOVA).

Results showed that integration dimension of Chemistry laboratory learning environment has the most significant effect on the learners' performance, closely followed by Students Cohesiveness and Open-endedness. Results also indicated that student cohesiveness dimension of laboratory learning environment has the most significant effect on the learners attitude, closely followed by rule clarity. The study recommended among others that the five dimensions of the laboratory learning environment should be used to determine the actual situation of the Chemistry laboratory learning environment. This would enable the Chemistry teachers know the particular environment variable(s) that would enhance the teaching and learning of the subject.

This study is closely related to the present study as both were conducted in SeniorSecondary Schools. They both examined Chemistry students' performance and both adopted the quasi-experimental research design. The differences that exist between both are that the reviewed study was on laboratory teaching environment while the present study was on laboratory teaching method.The reviewed study used SSIII Chemistry students as respondents while the present study used SS II Chemistry students. The reviewed study used two instruments which were Chemistry Practical Achievement test (CPAT) and Chemistry Attitude Scale (CAS) but the present study used only Chemistry Students Performance and Retention (CSPRT). The present study was conducted in Kaduna State while the former was carried out in Ondo State.

Onwirhiren (2015) conducted a study to determine how academic achievement and retention in Chemistry is enhanced through discussion and lecture methods among SSII students in Chemistry in Benue State. The purpose of the study was to determine

the achievement scores of students taught Chemistry with discussion and lecture methods, determine the retention of male and female students in Chemistry when taught with discussion and lecture methods. Three research questions and null hypotheses were raised in line with the purpose of the study.

The study adopted a quasi experimental design. A total population of 118 SSII students was sampled out of a total population of 3,101from three schools in Gboko Local Government Area of Benue State using purposive random sampling. Data were collected using a 30 item multiple choice Chemistry Achievement Test (CAT) in organic Chemistry, since there were randomization of the subjects into groups thus, intact classes were used from coeducational schools offering Chemistry. Three hypotheses were generated and tested at 0.05 level of significance. Data collected were analysed using descriptive statistics, t-test, spearman correlation co-efficient and Analysis of Variance (ANOVA). The results showed that discussion instructional strategy significantly improved students' performance and retention better than the lecture method. It further showed that discussion method enhanced better achievement and productivity than the lecture method. The reviewed study is related to the current study in terms of focus and approach. Both studies adopted quasi-experimental design using intact classes and the respondents were SeniorSecondary School II Chemistry students. They both had discussion as a teaching method examined and both adopted the quasi experimental research design. However, the studies differ in the location of study, while the reviewed study was carried out in Benue State; the present study was conducted in Kaduna State. Also, the reviewed study determined the achievement and retention of students' taught with discussion and conventional methods of teaching but the present

study evaluated the effectiveness of laboratory and discussion methods on students' performance.

Amadi, (2016) conducted a study on the effects of demonstration and discussion methods of teaching on students' achievement interest in some graph related concepts in Economics in Imo State. The main purpose of the study was to determine the effect of demonstration and discussion method of teaching on students' achievement and interest in some graph related concepts in Economics. The study adopted a quasi-experimental design a non-equivalent control group design. The population of the study comprised of all SSII students in Ikeduru Local Government area in Imo State. Two intact classes were sampled out of which one of the classes was taught using demonstration teaching method while the other was taught using discussion method. Two instruments were used for data collection namely: Economics Achievement Test (EAT) and Economics Graph Interest Scale (EGIS). Analysis of covariance (ANCOVA) was used to test the hypotheses at .05 level of significance. The result of the study showed that discussion teaching method increases students' interest and achievement in graph related concepts in Economics. The study recommended that Economic teachers should endeavor to develop and adopt the use of discussion method as it would enhance coverall interest and achievement in economics as well as help reduce gender gap in the subject. The similarity between the studies is that both used quasi experimental research design on achievement of students. They both used SSII students as well. The differences are that the reviewed study was on demonstration and discussion teaching methods in Economics while the present study is on laboratory and discussion teaching methods in

Chemistry. They also differ in the area of location, while the present was in Kaduna State; the former was in Imo State

Mwangi, (2016) carried out a study on effect of Chemistry practicals on students' performance in Chemistry in public Secondary Schools of Machakos and Nairobi countries in Kenya. The purpose of the study was to investigate the effect of Chemistry practicals on students' performance in Chemistry in Machakos and Nairobi counties' public Secondary Schools. The main objective of the study was to establish if there is any significant difference in academic achievement in Chemistry between students exposed to Chemistry practicals and those not exposed. Other areas investigated were the relationship of Chemistry practicals and performance in Chemistry between students of mixed gender schools and those of single gender schools. Quasi-experimental pre-test post-test control group was used as the research design. The population for the study comprised of all form II students who were taking Chemistry and all Chemistry teachers in Public Secondary Schools in Machakos and Nairobi counties in Kenya. A sample of 24 out of 272 public Secondary Schools in Machakos and Nairobi counties was used for the study. Learners' performance in Chemistry was determined by scores obtained by students in Students' Achievement Tests (SAT) done just before and immediately after exposure to the topic under investigation. Data relating to teachers and students views on the use or non use of Chemistry practicals and its effects on performance in Chemistry were collected using questionnaires. The computer package SPSS (Statistical package for Social Scientists) was used to analyze the data. Descriptive statistics such as frequency, mean, percentages, and standard deviation was used to discuss the research findings. The study also used inferential statistics such as

ANOVA, ANCOVA, independent T-test and multiple regressions to test the statistical significance in the four null hypotheses generated for the study. It was found that the use of Chemistry practicals in teaching and learning of Chemistry at Secondary School level, improved performance in the subject. The similarities between both studies are that they employed the use of same research design and both studies tried to ascertain the effect of laboratory activities on Chemistry students' performance. Both studies were carried out in public schools and used SSII class level. However both studies differ in the location. The reviewed work was carried out in Kenya while the present work was conducted in Nigeria.

Omwirhiren and Suleiman (2016) carried out an investigation on The Effects of Laboratory, Guided-Unguided Discovery (Inquiry) And Lecture-Demonstration Teaching Methods On Senior Secondary Students' Achievement In Acid-Base Titration Practical Test In Selected Secondary Schools In Giwa Local Government Area Of Kaduna State, Nigeria . A pre-test, post-test experimental design with a control group was used. A total sample of 123 students within an average age 17 years in SSII & SSIII of four (4) SeniorSecondary Schools were randomly selected from Giwa local government area of Kaduna State, Nigeria. The research instruments developed were twenty four item supply/select response including objectives and essay questions used for the pre-test and post-test tagged acid-base achievement test (ABAT). Students were divided into three experimental and one control group. Students in the three experimental groups were subjected to treatment using laboratory, inquiry (guided-unguided discovery) and lecture-demonstration method respectively while students in the control group were taught using traditional method of teaching. The pre-test was

administered to students in all the four (4) groups before teaching commenced and after the teaching and the experiment, a post-test was then administered.

The data was analyzed using mean, standard deviation, t-test and one way analysis of variance (ANOVA). The result of ANOVA of the difference in the scores of the post-test of the laboratory, inquiry, lecture-demonstration method and control group showed a significant difference between the groups.

A research conducted by Alasoluyi, (2017) on the effects of project and discussion methods on students' performance in Economics in SeniorSecondary Schools in Ekiti State, Nigeria. Five objectives were formulated for the study among which are to: ascertain the effect of project and conventional method on the performance of economics students in SeniorSecondary Schools, Ekiti State; determine the effect of discussion and conventional method on the performance of economics students in SeniorSecondary Schools, Ekiti State; and find out the performance of students taught economics using project and discussion methods in urban and rural SeniorSecondary Schools in Ekiti State. In line with these objectives, five corresponding research questions and hypotheses were formulated for the study. Relevant literatures on the key variables of the study were reviewed, while the study was anchored on three relevant theories, such as Constructivist Learning Theory, Gagne's Theory of Instruction, and Cultural-Historical Activity Theory.

The study adopted quasi-experimental research design. The target population of the study was made up of 10,784 SSII students from the entire 183 public Secondary Schools in Ekiti State. The sample size for the study consisted of 212 SSII students from six schools with intact classes. This sample size was arrived at using purposive sampling

technique. The instrument tagged “Economics Students Project and Discussion Test” (ESPDT) was used for the purpose of data collection in the study. Independent sample t-test and Analysis of Covariance (ANCOVA) were used to test the hypotheses advanced for the study at 0.05 level of significance. Findings from the study among others on hypothesis one did not reveal significant difference between the performance of Economics students taught with project and conventional methods in SeniorSecondary Schools in Ekiti State (p-value .699 > 0.005). However, findings on hypothesis two revealed that students taught economics using discussion method had a better performance mean score than students taught using conventional method in SeniorSecondary Schools in Ekiti State (p-value .003 < 0.005). Findings on hypothesis three also showed that students taught economics using discussion method performed better than those taught using project method in urban and rural SeniorSecondary Schools in Ekiti State (p-value .000 < 0.005).

In view of the findings from this study, conclusion was drawn that project method can be effective when combined with other methods in teaching Economics. The result of the study also proved that different methods suit different purposes and abilities, discussion method has been proved to be more effective in developing social and analytical skills in students. Based on the findings of this study, it was recommended among others that teachers of Economics should ensure that daily class work and assignment given to students include relevant project activities as much as possible. Teachers should also promote discussion as a method of teaching Economics as it will encourage and motivate students to participate actively in class. Furthermore, students’ listening and speaking skills can be enhanced through discussion method.

The similarities of the previous research to the present study are that both studies adopted quasi-experimental design and made use of SSII students as respondents. Both studies also had discussion as a teaching method examined. They differ in the subject area and location. While the reviewed study was in Economics subject in Ekiti State, the present study was in Chemistry subject in Kaduna State. Also, the former study examined project teaching method while the Katter examined laboratory teaching method.

Jack and Suleiman (2017) conducted a study on "Effectiveness of Guided-Inquiry Laboratory Experiments" on SeniorSecondary Schools Students Academic Achievement in Volumetric Analysis in Taraba State. The purpose of the study therefore, was to investigate the effects of guided-inquiry laboratory experiments on SeniorSecondary School students' academic achievement in Volumetric Analysis. The design for the study was a pre-test post-test control group quasi-experimental design. The instrument used for data collection was Volumetric Analysis Achievement Test. The statistical tools used for data analysis in the study were means, t-test and Analysis of Covariance.

The findings from the study showed that guided-inquiry laboratory experiments had significant effect on students offering chemistry' academic achievement than the traditional teaching method since it motivated the students and this was positively reflected in their chemistry mean achievement scores. The findings also revealed that gender has no significant effect on academic achievement of students exposed to Chemistry through guided-inquiry laboratory experiments. This showed that males and females benefited significantly from the instructional approaches; since it was student-

activity oriented which made them engaged in in-depth critical thinking and process skills. The findings of this study imply that guided-inquiry laboratory experiments had much more effect on students' academic achievement than the traditional teaching method. Chemistry teachers should therefore incorporate it into the teaching-learning process since it developed students scientific and practical skills, motivated the students and fostered the spirit of competitiveness among them; and its effectiveness is not being limited by gender.

The reviewed study and the present study are similar in the area of subject examined which was Chemistry; they both adopted the quasi experimental research design and used achievement test as instrument for data collection but they differ in the instructional strategy. While the reviewed study was on Guided-inquiry laboratory experiment, the present study was on laboratory and discussion method. The former study was conducted in Taraba State while the present study was carried out in Kaduna State.

Namasaka, Mondoh and Wasike, (2017) conducted a study on Effects of sequential teaching methods on retention of knowledge in Biology by Secondary School students in Kenya .The purpose of this study was to compare differential effectiveness of Sequential Teaching Methods (STM) on the, retention of knowledge in Biology by Secondary School students. The study was Quasi- experimental using the Non-equivalent control- group 16 study design. The target population comprised students in the 18 old category National Schools in Kenya that were in existence before 2012. Purposive sampling was used to obtain a sample of eight (8) schools and 402 Students. The students in the eight (8) sub-groups were taught the same Biology topic: "General

Characteristics of Enzymes", using different sequences of three teaching methods namely: lecture, slide demonstration and laboratory (student experiment). Group I (ELD) began with experiments, followed by lecture method and was lastly shown, animated slides. The sequence of the three different methods used in the first group was altered in both the second and third groups as follows: The lecture method, slide demonstration and laboratory experiment (LDE) for Group II, and slide demonstration, experiment and lecture method (DEL) for group III. Students in group IV (control group) were taught using (oral-only) lecture method. The teachers gave lectures and performed slide demonstration while the students carried out laboratory experiments. The test was used as a pre-test and also as a retention test that was administered 40 days after the Post-test BAT. This test had 25 objective questions testing knowledge of facts, application of knowledge and problem solving ability. To measure Retention of Knowledge, the researcher used Biology Retention Test (BRT).

The research hypothesis was tested using ANOVA at significant level of 0.05. The results and findings of the study showed that STM, when efficiently used in instruction enhance immediate retention of knowledge in Biology more effectively than the oratory lecture method predominantly used in Kenyan Secondary Schools. Furthermore, DEL sequence was identified as the most effective in comparison to LDE and ELD.

The reviewed study and the present study are similar in the area of design used as they both adopted the quasi experimental research design and used achievement test as instrument for data collection but they differ in the instructional strategy. While the reviewed study was on sequential teaching method (lecture, slide demonstration and

laboratory) the present study was on laboratory and discussion method. The former study was conducted in Kenya while the present study was carried out in Kaduna State.

A research was carried out by Sanda and Mazila (2017) on "The Effect of Lecture and Discussion Methods of Teaching on Learner's Performance in Social Studies in Continuing Education in Borno State, Nigeria". The study examined the effects of lecture and discussion methods of teaching on learners' performance in social studies in Continuing Education Institute, Borno State. This study used empirical research design, while random sampling technique was used in selecting fourty (40) learners from the Basic Adult Education Programme. Social studies performance tests of 10 items objective test was used as the instruments for data collection. Single factor analysis of variance was used in analyzing the data obtained. Two research questions guided the study; (1) is the performance of learners taught with lecture method significantly higher in the post-test than the pre-test? (2) Is the performance of learners taught with discussion significantly higher in the post-test than the pre-test? Two hypotheses were raised in line with the objectives. The single factor analysis of the calculated F value were less than the tabulated F values at 5% level of significance df 9. Thus, the null hypotheses were rejected.

The overall outcome of the study showed that, discussion method of teaching stands as an effective method of enhancing learners' performances in social studies. The study recommended that discussion method of teaching should be adopted into social studies teaching in the Basic Adult Education Programme in Borno State. Discussion method should be incorporated into teacher education programmes so as to acquaint teachers/institutors with the tenets. The government should organize on the job trainings,

workshops, seminars symposia and conferences at intervals for the instructors/teachers of social studies in learning institutions to update their knowledge on the application of discussion method of teaching the subject. The reviewed study and the present study are similar as both study had discussion as a method of teaching examined but they differ in the subject and location. While the present study was conducted in Chemistry and in Kaduna State, the reviewed study was carried out in Social study in Borno State.

Chucks and Chidubem (2018) carried out an investigation on the effects of laboratory instruction against lecture method on students' attitudes in some Chemistry Concepts at SeniorSecondary School level in Rivers State. A total of 230 Senior secondary one (SS1) chemistry students were involved in the study. This number was made up of 100 males and 130 females from five Secondary Schools in Ahoada West Local Government Area of Rivers State of Nigeria. A non- randomized pretest- post-test control group was used for the study. Cronbach Alpha was used to establish the reliability of the Chemistry Students' Attitude Scale (CAS). The reliability coefficient of CAS was 0.75 .To analyze the data of the study, the research questions were answered using mean and standard deviation scores. Hypotheses were tested using analysis of covariance (ANCOVA). From the findings, it was observed that laboratory instruction was the most effective in facilitating students' attitudes while lecture was found to be the least facilitative method. Attitude is dependent on teaching methods. Students' attitude mean scores in practical chemistry (acids and bases) were significant. The interaction effect of gender and teaching methods on students' attitude mean scores in practical chemistry (acids and bases) were not significantly different. The interaction effect of gender and teaching methods on students' attitude mean scores in practical chemistry

(acids and bases) were not significantly different. The study recommended among others that laboratory instruction should be used by teachers in teaching practical chemistry contents (acids and bases) to guarantee effective instructional delivery.

The reviewed study is related to the present study as they both adopted the quasi experimental research design. Both studies also examined Chemistry as the teaching subject. Despite the similarities the studies differed in the level of respondents. While the reviewed study made use of the SSI students as its respondents, the present study used SSII students. Also, the reviewed study was conducted in Rivers State while the present study was carried out in Kaduna State.

Ugan, B. (2019), conducted a study titled "effects of cooperative and laboratory methods on performance and retention of students in Chemistry in Secondary Schools in Jigawa State, Nigeria." The study was carried out with six objectives, which are to; find out the effect of cooperative learning strategy on academic performance of students in Chemistry when compared to conventional lecture method; ascertain the effect of cooperative learning strategy on students' retention ability in Chemistry; investigate the effect of laboratory -based strategy on students' performance in Chemistry when compared to conventional lecture method and determine the effect of laboratory -based strategy on students' retention ability in Chemistry among others. Six research questions and six hypotheses were formulated in line with the above mentioned objectives. The study employed quasi - experimental design with a total population of one thousand three hundred and thirty two (1332) and a sample size of three hundred and four (304) which was arrived at using purposive sampling technique. The Data for the study was collected through pre-test, post-test and retention test using teacher made test titled Acid

Base Performance Test (ABPT) as instrument. The data collected were analyzed statistically using Statistical Package for Social Sciences (SPSS), version 20. At descriptive level, the research questions were answered by using mean and standard deviation. While at inferential level, hypotheses 1-4 were tested using t-test, also hypotheses 5 and 6 were analyzed using Analysis of Variance (ANOVA).

The findings of the study revealed that students taught the concept of acid and base using cooperative learning strategy performed significantly than those taught the same concept using conventional method of teaching in Secondary Schools in Jigawa State and Significant difference exists between the performance of students taught Chemistry concept using laboratory-based strategy and those using lecture method in Secondary Schools in Jigawa State among other findings. Based on the findings, it was concluded that students taught Chemistry using cooperative learning strategy performed significantly better than those taught using conventional method in Secondary Schools in Jigawa State and teaching students using cooperative learning strategy significantly enhanced students' academic retention ability in Chemistry compared to those taught using lecture method in Secondary Schools in Jigawa State among others. It was recommended among others that teachers, school managers and school support officers should promote the use of cooperative learning strategy as a commonly use strategy in classrooms as it will promote and encourage students to work together thereby enhancing students retention ability; and Chemistry teachers should use laboratory-based strategy as a common strategy in teaching in order to enhancing students' performance in Chemistry. The researcher also developed a cooperative learning model

tagged "Field-Jigsaw Cooperative Model (FJCM)" with the view to guide teachers and researchers alike on how to use the model in teaching and learning.

The studies are similar in subject area which is Chemistry; they also adopted same research design and both examined the laboratory instruction on performance and retention of Chemistry students. The differences between both studies is that the reviewed study had cooperative learning strategy in place of discussion method in the present study, also the reviewed study was carried out in Jigawa State while the present study was in Kaduna State.

2.9 Summary of Reviewed Related Literature

The study focuses on the “Evaluation of the effects of Laboratory and Discussion Methods on Chemistry Students Performance and Retention in SeniorSecondary School Kaduna State, Nigeria”. The chapter looked at conceptual framework, concept such as; laboratory and discussion methods of teaching. Laboratory is where the students become involved with their environment in such a way that, the theories and principles encountered and discussed during the lesson can have a meaning. Laboratory function is to provide the students with required skills to stimulate their knowledge, Laboratory is a place where knowledge is discovered when these are not available and teaching and learning becomes too theoretical to have desired impact on students as well as give lectures satisfactions. In the course of literature reviewed, the study discovered that both teachers and students of Chemistry have found the laboratory a unique place to carry out their studies. The researcher observed that laboratory help students to plan and experiment to solve a problem, ability to carry out the experiment and ability to interpret results obtained and draws conclusions.

Discussion method is meant to provide for the needs of individual students or sometimes small groups so that those with special abilities have opportunities to fulfill themselves. Discussion method is a method of teaching used when the class has some central interest around which all the work of the class is centered for a given period. The study observed that it gives students the opportunity to reflect deeply concerning issues, in addition, it helps students to have the skills of critical analysis over issues. The study reviewed literatures considered very relevant to this present study. This study is unique as compared to other studies reviewed because, some of the previous studies were conducted using survey research design, even those conducted using experimental were carried out at Junior Secondary Schools and none was conducted in Kaduna State. Despite the numerous researches reviewed on the use of laboratory and discussion methods, none was conducted on the use of laboratory and discussion method on performance and retention in teaching Chemistry. Hence, the conduct of this study becomes imperative in order to evaluate the effect of Laboratory and Discussion Methods on Chemistry Students' Performance and Retention in SeniorSecondary Schools in Kaduna State, Nigeria.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter explains the methodology used in conducting this study. These include; research design, population of the study, sample and sampling techniques, determination of sample homogeneity, instrumentation, table of specification, treatment package, validity of the instrument, pilot study, reliability of the instrument, treatment procedure, administration of treatment to the experimental groups (Laboratory and Discussion), control of extraneous variables, procedure for data collection and procedure for data analysis.

3.2 Research Design

The research design used for this study was quasi-experimental research design. The pre-test, post-test and post-post-test of non equivalent groups was used. Intact classes were used for the study. This design according to Olayiwola, (2007) provides some degrees of controlfor possible extraneous variables that might affect either the internal or external validity or both. According to Kumar (2015), an experimental research design is the most appropriate design for measuring the impact or effectiveness of a program, where one group (s) is treated and the other is not. The study consisted of two (2) experimental groups: Laboratory Method which represented experimental group 1, Discussion Method represented experimental group 2, and Conventional Method held for the control group. The students in both experimental groups (laboratory and discussion methods) and the control group (conventional or lecture method) were exposed to pre-test before the administration of treatment to the experimental groups. A

post-test was given to both the experimental and control group in their respective schools after treatment was administered to the experimental group. Below is a diagrammatical illustration of the research design:

Table 2: Experimental Groups(EG) and Control Groups (CG)Represented as Follows

Group	Pre-test	Treatment	Post-test	Post-post test
EG 1	X_0 ⟶	X_1 ⟶	X_3 ⟶	X_4
EG 2	X_0 ⟶	X_2 ⟶	X_3 ⟶	X_4
CG 1	X_0 ⟶	$X0_1$ ⟶	X_3 ⟶	X_4
CG 2	X_0 ⟶	$X0_2$ ⟶	X_3 ⟶	X_4

Keys:

Experimental 1:- Stands for experimental group one (LM)

Experimental 2:- Stands for experimental groups two (DM)

Control Group 1- Stands for control group one (CM)

Control Group 2- Stands for control groups two (CM)

X_0, stand for pre-test for the four groups

X_1 and X_2stand for treatment for the experimental groups

Xo_1 and X_{02} represent no treatment for the control groups

X_3, stand for post-test for all the groups

X_4 stand for post post-test for all the groups

3.3 Population of the Study

The population of the study was made up ofall public Senior Secondary two (SSII) school students offering Chemistry across the twelve (12) Quality Assurance Authority (QAA) divisions of Kaduna States. There wereeighteen thousand one hundred and thirty eight **(**18,138**)** Public SeniorSecondary School II Chemistry students' across the 23 local governments in Kaduna State, Nigeria. This population consisted of twelve thousand, three hundred and forty (12,340) male students and five thousand seven hundred and nicety eight (5,798) female students. This category of students was targeted for the study because of their experience in Chemistry and stability in schools more than SeniorSecondary Schools I students, who had not yet gained much academic experience and the SeniorSecondary Schools III students who were preparing for SSCE examination. The detail of the population is given in table 1.

Table 3: **Population of the study**

S.N	**Population distribution of schools QAA Divisions**	**Population of SSII Students**		
		Boys	**Girls**	**Total**
1	Sabon tasha	976	292	1,268
2	Zaria	2,457	1,475	3932
3	Lere	591	168	759
4	Kachia	959	345	1,304
5	Kaduna	1,230	969	2,199
6	Kafanchan	762	198	960
7	Godogodo	985	341	1,326
8	Rigachikun	880	364	1,244
9	Zonkwa	1,107	209	1,316
10	Anchau	635	280	915
11	Giwa	593	274	867
12	Birinin Gwari	1,165	883	2,048
	Total	**12,340**	**5798**	**18,138**

Source: Ministry of Education Science and Technology (MEST) Kaduna State 2018/ 2019 enrolment.

3.4 Sample and Sampling Techniques

The total sample size for the study was four (4) intact classes of two hundred and seven (207) SSII Chemistry students from Zaria Education Zone of Kaduna State, Nigeria. The schools were Government Secondary School Tudun Jukun, Government Secondary SchoolDakace, Government Secondary School Dogon Bauchi Seniorand Barewa College. These schools were sampled from both within and out skirts of Zaria respectively and were assigned experimental and control group. Purposive sampling

techniques was adopted to ensure subjects chosen included both males and females who had similar background experience and were exposed to similar infrastructure.

The sample for the experimental group I was made up of fifty one (51) students, experimental group II was made up of fifty three (53) students while the control group 1 consisted of forty eight (48) students and control group 11 consisted of fifty five (55) students. The sample size for the study is represented in the table 2.

Table 4: **Sample Distribution for the Study**

S/N	Schools	Group	Male	Female	Total
1	Barewa College (Laboratory method)	Experimental 1	51	-	51
2	G.S.S Tudun Jukun (Discussion method)	Experimental 1I	1538	53	
3.	G.S.S Dakace (Conventional)	Control	202848		
4.	G.G.S.S Dogon Bauchi (Conventional)	Control	-	55	55
	Total		86	121	207

3.4.1 Determination of Samples Homogeneity

The students sampled for this study were from different Local Government Areas of the senatorial Districts within Kaduna State. Their homogeneity was determined by considering the fact that the students shared similar characteristics like school type, co-educational, admission requirements, they operated the same syllabus, used the same type of textbooks, similar culture and tradition. This was done in order to reduce the

chances of bias, error variance with either group and inaccurate measurement and evaluation.

3.5 Instrumentation

The instrument used for gathering information was tagged “Chemistry Students Performance and Retention Test (CSPART).” The instrument was used to determine the students’ prior knowledge and understanding of Chemistry concepts before treatment as well as their retention in both experimental and control schools after treatment. A post-test was administered after eight weeks of treatment while a post-test (retention test) was administered after two weeks of the post-test. The instrument consisted of fifty (50) multiple-choice objective assessment items based on the Chemistry concepts taught from SSII Chemistry curriculum. The students were made to select correct answers from four options A-D, Chemistry topics that were taught which included: concept and structure of water, solubility, hardness and removal of harness of water, purification of water and production of distilled water as contained in Senior Secondary schools Chemistry curriculum of Nigeria Educational Research and Development Council (NERDC).The researcher adopted test items that are developed from SeniorSecondary School Certificate Examination (SSCE) past questions of both WASSCE and NECO and some self developed test items.

3.5.1 Table of specification

The table of specification also known as a test blue print according to Alade and Omoruyi (2014), is a two –way chart designed based on the list of course objectives, the topics to be covered in class, the amount of time to be spent on these topics, and the emphasis and space that is provided in the text. It guides the teacher on the activities

which enumerate the information on tasks on which exams are to be assessed or evaluated. The table was designed in such a way that it concentrated on the content areas coveredwith emphasis on instructional objectives.

Table 5: Specification table for a fifty (50) items Chemistry student's performances and retention test for SSII

S/N	Content	Weight (%)	Knowledge (25)	Comprehension (23)	Application (15)	Analysis (13)	Synthesis (12)	Evaluation (12)	Total items
1	Concept and structure of water	18	2	1	1	2	1	1	8
2	Solubility solute, solvent and solution	20	3	2	1	1	1	1	9
3	Factors that affect solubility	23	4	3	1	1	2	1	12
4	Hardness and removal of hardness	20	3	2	2	2	1	1	11
5	Producti-n of distilled water	20	2	2	3	1	1	1	10
	Total	100	14	10	08	07	06	05	50

Outline of topics based on the selected curriculum content areas.

From the table, it would be seen that five (5) content matter areas were outlined. These areas are: concept and structure of water, solubility (solvent, solute, and solution), factor that affect solubility, hardness and removal of hardness and production of distilled water. Factors that affect solubility attracted 12 items, the least i.e. 8 items was for concept and structure of water. For weight of contents, the knowledge level had 14 items

as highest and the evaluation had the least. The distribution of number of items in each topic (i.e. for each level of the subject matter) was a reflection of the emphasis and the importance the researcher attached to these areas. This table of specification was designed to guide the researcher in constructing the test items.

3.5.2 Treatment package

The treatment package helps the teacher to relate their instructional objectives, the cognitive, affective and psychomotor domain level of instruction. Since teacher cannot measure topics of his own wish, thus a treatment package assists the teacher to construct a test that will strictly focus different weight and areas. The treatment package for the study is presented in table 4.

Table 6: Treatment Package

	Content	**No of items**	**No of items for pre-test**	**No of items for post test**
1	Concept and structure of water	2,1,1,2,1,1	08	08
2	Solubility(solvent, solute and solution)	3,2,1,1,1,1	09	09
3	Factorsaffectingsolubility	4,3,1,1,2,1	12	12
4	Hardness and removal of hardness of water	3,2,2,2,1,1	11	11
5	Production of distilled water	2,2,3,1,1,1	10	10
	Total	14,10,8,7,6,5	50	50

Table 6 shows the topics covered by the test instruments and number of test items associated with each topic. This table enabled the researcher to cover all the topics/contents without bias.

3.5.3 Validity of the Instrument

The Chemistry Students Performance and Retention Test (CSPART) were validated by researcher's supervisors in the Department of Educational Foundations and Curriculum, Faculty of Education, experts from the field of Science Education Department, test and measurement and evaluation,Ahmadu Bello University Zaria. The CSPART (for pre/post-test) marking scheme items for laboratory and discussion methods as well as the lesson plans for the controlled group were examined for content and construct validity and appropriateness for the experimental groups. The test instrument was increased from the initial 35 to 50 test items in line with the corrections and recommendations made by these experts. This supported the view of Berge cited in Alasoluyi (2015), that for any research instrument to ascertain its validity, it should be given to panel of experts to determine if its items can elicit the desired data they are intended to elicit or not.

3.5.4 Pilot Study

A pilot study was conducted at G.S.S Kongo to ascertain the reliability of the instrument for the study. This is in line with Olaofe, (2010) who Stated that to ensure reliability of the instrument; a pilot study is required before the main study is carried out. The instrument was administered to an intact class of fifty six (56) SSII students as the experimental group and also an intact class of thirty two (32) SSII Students as the control group. The school selected for the pilot study was similar to the sample schools in terms of status, level and location. The tests re-test method with an interval of two weeks using CSPART instrument was administered to the students in the experimental and control group respectively.

The purpose of the pilot study was to;

i. determine the reliability of the instrument before use,

ii. assess the feasibility of the study before administration;

iii. determine the amount of materials required to effectively teach the subject during the main study; and

iv. identify the problems of difficulties that respondents may encounter with the aim of overcoming them in the final instrument.

3.5.5 Reliability of the Instrument

The result of the pilot test on Chemistry Students Performance and Retention Test (CSPART) were analyzed in order to determine the reliability of the instrument. The test re-test method was employed and the result was analyzed using Pearson Product Moment Correlation Coefficient (PPMCC) in the statistical package for social science (SPSS, Version 20). A reliability co-efficient(r) level of 0.75 was obtained. This showed that the instrument was reliable and valid for use in the main study as pointed out by Obeka (2011), that the closer a reliability coefficient is to the value of 1.00, the more reliable the instrument is free from error variance. Also, the formula was used because it has been found by Olayiwola, (2007) to be particularly useful to teachers as it requires less computation and is useful when items are in multiple forms.

3.6 Procedure for Data Collection

The researcher collected a letter of introduction from the Head of Department, Educational Foundations and Curriculum, Faculty of Education, Ahmadu Bello University, Zaria to the respective schools, seeking their permission as well as the co-

operation of the entire school community in order to have a successful field work. Before that time, the researcher trained two research assistants who were responsible in helping the researcher where necessary, they were briefed on the main objectives of the field work, the modalities involved in the research work as well as how to respond to the entire school community. The researcher trained the research assistants for the period of 2 days. The Pre-test was administered on students before the commencement of the treatment. Ten weeks was used for the laboratory activities (treatment 1) and discussion session (treatment 2), while the Control group were exposed to the Conventional (lecture) method on the same content used for experimental groups. After the treatment, the researcher administered a post-test, which the researcher marked and recorded their test scores before taking for analysis.

3.6.1 Treatment Procedure

The treatment procedure for Laboratory and Discussion Methods is presented as follows:

Treatment procedure for Laboratory method: -The treatment procedures for laboratory Method entail the following steps:

Step 1: The teacher clearly defined the task

Step2: Students were assigned into groups. For example, the entire class of 50 students was divided into five groups of 10 students each for easier handling of the laboratory activity. Each groups selected their group leader among its members.

Step 3: Students were given rules to follow. Students within the groupsshould:

i.appreciate the need for cooperator and hard work in a group assigned work.

ii.understand the fact that success and better performance are the end result of a dedicated work towards a visualized goal.

iii.value the importance of punctuality and constant attendance in school

Step 4: Each groups were assigned roles and assignments**.**

Step 5: The teacher gave each group their task

Step 6: The teacher asked each group to compile, organize, write and present a report to the entire class as regards the different areas assigned to them through an appointed group chairman.

Step 7: The teacher called for the meeting of the entire class to deliberate the various reports. Each group presented their report on the activities through the groups representatives to the entire class.

Step 8: Students were given assignments. The teacher instructed the learners to consult relevant textbooks, library or places on the next laboratory activity.

Treatment Procedure for discussion Method:- The treatment procedures for discussion method entailed the following steps:

Step 1: The teacher gave the topic to be discussed and gave relevant examples to stimulate students' interest in the discussion.

Step 2: Students were divided into groups. For example, the entire 45 Students in the class were pairedinto small groups of nine students to carry out discussion activities and share their ideas. After this, each group appointed a leader among its member.

Step 3: Students were given rules to follow. Students within the groups should:

i.understand the need to carry out laboratory experiments and share their ideas together

ii. respect opposing opinion for a peaceful coexistence

iii. appreciate the importance of punctuality and regular attendance in school.

Step 4: Each group was assigned the same task to discuss on and share ideas on the introduce topic

Step 5: The teacher moved from one group to the other, listened to the trend of discussion in each group. The teacher gave suggestions and advised where necessary.

Step 6: The teacher asked each group to compile, organize, write and present report to the entire class as regards the different areas assigned to the students in each group.

Step 7: The teacher called for the meeting of the entire class to deliberate the various reports. Each group presented a summary of their report of the discussion through the groups representatives to the entire class.

Step 8: Students were given assignment. The teacher instructed the learners to consult relevant textbooks, library or places on the next laboratory experiment topic.

3.6.2 Treatment plan

The treatment plan for the groups covered Ten (10) weeks of teaching using different instructional methods. Table 5 presents the treatment plan

Table 7: Treatment Plan for the Field Work

SN	Weeks	Activity	Topic	Comment
1	Before Treatment	Introduction and		This was carried out in both Experimental and control schools.

		familiarization		
.2	Before Treatment	Pre-test		Pre-test was administered to both experimental and control group.
3	Week 1	Treatment	Concept and structure of water	Students in experimental groups were taught using laboratory and discussion methods, while those in control group were taught same topic with conventional method.
4	Week 2	Treatment	Types, Sources and uses of water	Students in experimental groups were taught using laboratory and discussion methods, while those in control group were taught same topic with conventional method.
5	Week 3	Treatment	Solubility of substances	Students in experimental groups were taught using laboratory and discussion methods, while those in control group will be taught same topic with conventional method.
6	Week 4	Treatment	Solubility (solute, solvent and solution)	Students in experimental groups were taught using laboratory and discussion methods, while those in control group were taught same topic with conventional method.
7	Week 5	Treatment	Factors that affect solubility/uses of solubility curves	Students in experimental groups were taught using laboratory and discussion methods, while those in control group were taught same topic with conventional method.
8	Week 6	Treatment	Hardness of water and Removal of hardness	Students in experimental groups were taught using laboratory and discussion methods, while those in control group were taught same topic with conventional method.
9	Week 7	Treatment	Purification`of water and production of distilled water	Students in experimental groups were taught using laboratory and discussion methods, while those in control group were taught same topic with conventional method.
10	Week8-10	Evaluation activities	Post –test& post – post test	The researcher administered the post-test and post-post test after two weeks with the help of the trained research assistants, marked and recorded the tests

3.6.4 Control of Extraneous Variables

Extraneous variables are the variables that influence the outcome of an experiment, though they are not the variables that are actually of interest. These variables are undesirable because they add error to an experiment, hence, a major goal in research design is to decrease or control the influence of extraneous variables as much as possible.The following measures were adopted by the researcher to ensure that extraneous variables which might affect the result of the dependable variables were controlled. Some of these extraneous variables are:

1. Teacher variable

These variables were controlled by organizing a uniform training for the two research assistants that were involved in the study. The training programme provided the researcher the opportunity to identify the background knowledge of the research assistant on the Chemistry contents for the study and also to ensure that the assistant did not deviate from the procedural steps of the instructions. All the topics for the study were treated during the training using laboratory, discussion and lecture method lesson plans. This training helped in establishing a common standard.

2. Situational Variable:

This variable deal with the aspects of the environment that might affect the participant's behavior, such as noise, temperature, lighting conditions, and so forth. In the context of this study, situational variables were controlled by employing standardized procedures to ensure that conditions were the same for all participants.

3. Subject Interaction Variable:

The two teaching methods were used for the sampled schools for all SSII students. However, the data for the study were restricted only to the intact classes selected. Thus the teacher minimized subject interaction by ensuring that the board was cleaned up immediately after teaching and also, all the Chemistry students were seated in their classes before the commencement of teaching.

4. Demand characteristics:

These are all the clues in an experiment which convey to the participant the purpose of the research. Attempt was made in this research to minimize these factors by keeping the environment as natural as possible, carefully following standardized procedures. Also, in this study, the importance of professional demeanor of the experimenter during interactions with the participants was underestimated. This is because the quality of data that were obtained from human participants was directly related to the seriousness with which they assume their role as a research participant. If the experimenter is dressed unprofessionally, appears unprepared, or jokes around with participants, then the participants were less likely to take their participation seriously. They were less likely to follow instruction, attend to stimulus presentations, and do their best. All efforts to design a high-quality experiment can be wasted if the experimenter acts unprofessionally.

3.7 Procedure for Data Analysis

Data collected were analyzed statistically using appropriate tools in the statistical package for social science (SPSS) version 23. The research questions were analyzed using mean and standard deviation. Paired sample t-test statistics was used to test hypotheses one and two between the mean scores of the experimental groups.Paired

sample t-test was used because it compared two means that are from the same individual, object, or related units. The two means typically represent two different times (e.g. pre-test and post-test with an intervention between the two time points) or two different but related conditions or units.Independent t-test was used to test hypotheses three and four between the mean scores of the experimental and control groups respectively. Independent t-test was used because the variables measured involved two independent variables.Also, one way Analysis of variance (ANOVA) was used for hypotheses 5 and 6. This was because three independent variables were used that is, laboratory, discussion and conventional methods respectively. All the hypotheses were tested at 0.05 alpha level of significance.

CHAPTER FOUR

DATA ANALYSIS, RESULTS AND DISCUSSION

4.1 Introduction

The study was basically to assess the Effect of Laboratory and Discussion Methods on the Performance and Retention Ability of Chemistry Students in SeniorSecondary School in Zaria Educational zone, Kaduna State. To achieve this, the statistical Package of Version IBM 23 was used to analyze the data. The students were classified into two experimental groups of Laboratory and Discussion methods and a control group. Each group of students' were pretested and posted and also their retention ability recorded using their Post -Posttest scores. The analysis is presented in sections. The first section presents the bio data variables in frequencies and percentage distribution. These include the schools and study groups.The second section presents the answers to the six research questions using descriptive mean statistics. The third section contains results of the six null hypotheses tested. The first two hypotheses were tested with the Paired Sample t test for comparison between pretestand post test scores of the two experimental groups, while hypotheses 3 and 4 were tested with the independent t test statistics. Hypotheses 5 and 6 were tested with the Analysis of variance. All the hypotheses were tested at 0.05 alpha level of significance.

4.2 Analysis of Bio data variables in Frequencies and percentages

Table 8: Frequency Table

Schools	Frequency	Percent
Barewa college	51	24.6
GSS Tudun Jukun	53	25.6
GGS Dakace	48	23.2
GGSS Dogon-bauchi	55	26.6
Total	207	100.0

Based on the table, four Secondary Schools were used for the study. A total of 51 students, representing 24.6% were from Barewa College Zaria while 53 or 25.6% were from GSS Tudun Jukun as against 48 or 23.2% who are from GSS Dakace and 55 representing 26.6% from GGSS Dogon-Bauchi.

4.3 Description of the Study Variables

This section presents the analysis of the variables of the study using frequencies and percentages.

Table 9: Groups of the Respondents

Groups	Frequency	Percentage
Experiment 1 (Lab Method)	51	24.6
Experiment 2 (Discussion Method)	53	25.6
Control (Conventional method)	103	49.8
Total	207	100.0

Table 9 revealed that the students were classified broadly into three study groups. The first 51 students representing 24.6% were classified as experimental 1 taught Chemistry using the Laboratory method while the second consisted of 53 or 25.6% classified as experimental 2 taught Chemistry using the discussion method and the last group consisted of 103 representing 49.8% classified as control who were taught Chemistry using the conventional method.

4.4 Analysis of Response to Research Questions

The descriptive statistics of mean and standard deviation were used to analyze the data collected which was meant to provide answers to the stated research questions. The questions and the analysis were presented as follows:

Research Question One: What is the effect of laboratory method on the performance of students taughtChemistry in SeniorSecondary Schools in Kaduna State, Nigeria?

In order to provide answer to the Stated research question, data collected through the administration of Pretest and Post test performance of students taught Chemistryusing laboratory method in SeniorSecondary Schools in Kaduna State, Nigeria were analysed using mean and standard deviation. The analysis of data collected is presented as follow:

Table 10:Pre-test and post-test performance of students taught Chemistry using Laboratory method

Variable	Test	N	Mean	SD	Mean Diff.
Performance	Pretest	51	12.784	3.981	36.980
	Posttest	51	49.764	8.585	

Table 10 showed that the Pretest and Post test mean scores were 12.784 and 49.764 respectively with a mean difference of 36.980 in favour of the posttest. This indicates that the laboratory method had a positive effect and improved performance of

Chemistry students at the Post test level. However, the standard deviation at various levels implied that students had a varied performance in the test administration.

Research Question Two: To what extent does discussion method have effect on the performance of Chemistry students in SeniorSecondary Schools in Kaduna State, Nigeria?

Descriptive Mean statistics on difference in the Pretest and Post test performance of students taught Chemistryusing Discussion method in SeniorSecondary Schools in Kaduna State, Nigeria

Table 11: **Pre-test and post-test performance of students taught Chemistry using Discussion method**

Variable	Test	N	Mean	SD	Mean diff.
Performance	Pretest	53	11.622	3.420	10.943
	Posttest	53	22.566	6.461	

Table 11 showed that the Pretest and Post test mean scores were 11.622 and22.566 respectively with a mean difference of 10.943 in favour of the posttest. This indicates that discussion method had a positive effect and improved the performance of Chemistry students at the post test level. However, the standard deviation at various levels implied that students had a varied performance in the test administered.

Research Question Three: What are the differences in the retention ability of students taught Chemistry using Laboratory methodwhen compared with those taught with the conventionalmethod inSeniorSecondary Schools in Kaduna State, Nigeria?

Table 12: **Difference in the retention ability of students taught Chemistry using Laboratory and Conventional methods**

Variable	Method	N	Mean	SD	Mean diff.
Retention	Laboratory	51	51.019	8.36	36.39
	Conventional	103	14.621	6.18	

e 12 showed the difference in the retention ability of students taught Chemistry using laboratory method as compared with the conventional method in SeniorSecondary Schools in Kaduna State, Nigeria.Meanscores of 51.019 and 14.621 for laboratory and conventional methods respectively with a mean difference of 36.39in favour of the post-post-test was obtained. This indicates that the laboratory method had a positive effect and improved the retention ability of Chemistrystudents at the post-post-test. However, the standard deviation at various levels implied that students had a varied performance in the test administered.

Research Question Four: What are the differences in the retention ability of students taught Chemistry using discussion method and those taught with the conventional method in SeniorSecondary Schools in Kaduna State, Nigeria?

Descriptive Mean statistics on difference in the retention ability of students taught Chemistry using Discussion method and those taught with the Conventional method in SeniorSecondary Schools in Kaduna State, Nigeria

Table 13:Difference in the retention ability of students taught Chemistryusing and discussion and conventional method

Variable	Method	N	Mean	Std	Mean diff.
Retention	Discussion	53	21.283	6.064	6.661
	Control	103	14.621	6.18	

Table 13 showed the difference in the retention ability of students taught Chemistry using discussion method as compared with the conventional method in SeniorSecondary Schools in Kaduna State, Nigeria. The mean scores of 21.283 and 14.621 for discussion and conventional method respectively with a mean difference of 6.66 in favour of the post-post-test was obtained. This indicates that the discussion method had a positive effect and improved the retention ability of Chemistry students at the post-post-test. However, the standard deviation at various levels implied that students had a varied performance in the test administered.

Research Question Five: What are the effects of laboratory, discussion and conventional methods on the performance of Chemistry students in SeniorSecondary Schools in Kaduna State, Nigeria?

Table 14: Difference in the performance of students taught Chemistry using, Laboratory, Discussion and conventional methods

Descriptive Performance	N	**Mean**	**SD**
Laboratory method	51	49.765	8.585
Discussion method	53	22.566	6.461
Conventional method	103	20.000	6.231

Table 14 showed the differences in the performance of students taught Chemistry using laboratory, discussion and conventional methods. The mean scores were49.765, 22.566 and 20.000 respectively.This indicates that the use of laboratory method helped and had a positive effect on the performance of Chemistry students at the post test level more than the discussion and conventional methods. Similarly, the discussion method improved the performance of Chemistry students at the post test level when compared with the conventional method.However, the standard deviation implied that the performance of students varied far from each other.

Research Question Six: What are the differences in the Retention ability of students taught Chemistry using, laboratory, discussionand conventionalmethod inSeniorSecondary Schools in Kaduna State, Nigeria?

Table 15: Descriptive mean statistics on difference in the Retention ability of students taught Chemistry using Experimental and Conventionalmethod

Descriptive Retention	N	Mean	SD
Laboratory method	51	51.020	8.365

Discussion method	53	21.283	6.265
Conventional method	103	14.621	6.087

Table 15 showed the differences in the retention ability ofstudents taught Chemistry using laboratory, discussion and conventional methods. The mean scores were 51.020, 21.283and 14.621 respectively. This indicates that the use of laboratory method helped and had a positive effect on the retention ability of Chemistry students at the post-post-test level more than the discussion and conventional method. Similarly, the discussion method improved the retention ability of Chemistry students at the post-post-test level when compared with the conventional method. The standard deviation implied that the performance of students varied far from each other. However, retention rate of students taught Chemistry using conventional method declined faster than that of laboratory and discussion methods.

4.5 Hypotheses Testing

The results of the null hypotheses tested for the study were presented in this section. Altogether, six (6) null hypotheses were tested using paired sample t-test, independent t-test and Analysis of variance (ANOVA). The summary of each of the hypotheses tested was presented in the following order.

Hypothesis One: There is no significant difference in the Pretest and Post test performance of students taught Chemistry using laboratory method in SeniorSecondary Schools in Kaduna State, Nigeria.

The data collected through the administration of the instrument titled Chemistry Students Performance and Retention Test (CSPART) was analyzed using paired sample t-test.

Table 16:**Summary of Paired Sample t-test statistics on difference in the Pretest and Posttest performance of students taught Chemistryusing Laboratory method**

Var.	Test Groups	N	Mean	SD	Mean dif	Df	t-cal	t-crit	P
	Pretest	51	12.784	3.981					
Perf.					36.980	50	29.754	1.96	0.000
	Posttest	51	49.764	8.585					

Table 16 showed the Pretest and Post test performance of students taught Chemistryusing laboratory method in SeniorSecondary Schools in Kaduna State, Nigeria.The Pre test and Post test mean scores were 12.784 and 49.764 respectively with a mean difference of 36.980. The p value of 0.000 is lower than the 0.05 alpha level of significance and the t-cal of 29.754is higher than the t-crit of 1.96 at df 50. These indicate that the performance at the post-test was significantly higher. Therefore the null hypothesis which States that there is no significant difference in the Pretest and Post test performance of students taught Chemistry using laboratory method in SeniorSecondary Schools in Kaduna State, Nigeria, is hereby rejected.

Hypothesis Two: There is no significantdifference in the performance of students taught Chemistryusing Discussion method in SeniorSecondary Schools in Kaduna State, Nigeria.

The data collected through the administration of the instrument titled Chemistry Student Performance and Retention Test (CSPART) was analysed using paired sample t-test.

Table 17:Summary of Paired Sample T test statistics on difference in the Pretest and Post test performance of students taught Chemistry using Discussion method

Test Groups	N	Mean	SD	Mean diff.	df	t-cal	t-crit	P
Pretest	53	11.622	3.420	10.943	52	13.041	1.96	0.010
Posttest	53	22.566	6.461					

Table 17 showed the Pretest and Post test performance of students taught Chemistry using discussion method in SeniorSecondary Schools in Kaduna State, Nigeria. The Pre test and Post test mean scores were 11.622 and 22.566 respectively with a mean difference of 10.943. The p value of 0.010 is lower than the 0.05 alpha level of significance and the t-cal of 13.041is higher than the t-crit of 1.96 at df 52. These indicate that the performance of students taught Chemistry using discussion method was higher at the post-test level. Therefore the null hypothesis which States that there is no significant difference in the performance of students taught Chemistry using discussion method in SeniorSecondary Schools in Kaduna State, Nigeria, is hereby rejected because there was significant difference.

Hypothesis Three: There is no significant difference in the retention ability of students taught Chemistry using Laboratory method and those taught with the conventional method in SeniorSecondary Schools in Kaduna State, Nigeria

The data collected through the administration of the instrument titled Chemistry Student Performance and Retention Test (CSPART) was analysed using Independent sample t-test.

Table 18:Summary of Independent sample t-test statistics on difference in the retention ability of students taught Chemistry using Laboratory method and those taught with the conventional method

Groups	**N**	**Mean**	**SD**	**Mean diff.**	**df**	t-cal	t-crit	**P**
Laboratory	51	51.019	8.36					
				36.39	152	30.460	1.96	0.000
Convention	103	14.621	6.18					

Table 18 showed that difference existedin the retention ability of students taught Chemistry using laboratory method and those taught with the Conventional method in SeniorSecondary Schools in Kaduna State, Nigeria.The table showed the t-cal of 30.460 and t-crit of 1.96 at df 152, while p-value is 0.000 ($p<0.05$).The retention ability mean scores were 51.019 and 14.621 by students taught Chemistry using Laboratory method and those taught with the conventional method respectively with a mean difference of 36.39. Theseindicate that the retention ability of students taught Chemistry using laboratory method was higher at the post-post-test. Therefore, the null hypothesis two is thus rejected because there was significant difference.

Hypothesis Four: There is no significant difference in the retention abilityof students taught Chemistry using discussion method and those taught with the lecture conventional method in SeniorSecondary Schools in Kaduna State, Nigeria

The data collected through the administration of the instrument titled Chemistry Student Performance and Retention Test (CSPART) was analyzed using Independent sample t-test.

Table 19: Summary of Independent sample t-test statistics on difference in the retention ability of students taught Chemistry using discussion and conventional method

Variable	**Groups**	**N**	**Mean**	**SD**	**Mean diff.**	**df**	t-cal	t-crit	**P**
	Discussion	53	21.283	6.064					
Retention					6.661	154	6.412	1.96	.001
	Control	103	14.621	6.18					

Table 19 showed that difference existed in the retention ability of students taught Chemistry using discussion method and those taught with the Conventional method in SeniorSecondary Schools in Kaduna State, Nigeria. The table showed the t-cal of 6.412 and t-crit of 1.96 at df 154, while p-value is 0.001 ($p < 0.05$). The retention ability mean scores were 21.283 and 14.621 respectively with a mean difference of 6.661 in favor of students taught Chemistry using discussion method. The retention ability mean scores were 51.019 and 14.621 by students taught Chemistry using Laboratory method and those taught with the conventional method respectively with a mean difference of 36.39. These indicate that the retention ability of students taught Chemistry using discussion method was higher at the post-post-test. Therefore, the null hypothesis three is thus

rejected because there was significant difference in the retention ability of students taught Chemistry using discussion method when compared to those taught with the conventional method in SeniorSecondary Schools in Kaduna State, Nigeria.

Hypothesis Five: There is no significant difference in the performance of students taught Chemistry using laboratory, discussion andconventional methodsin SeniorSecondary Schools in Kaduna State, Nigeria

The data collected through the administration of the instrument titled Chemistry Student Performance and Retention Test (CSPART) was analyzed Analysis of variance (ANOVA)

Table 20 :Summary of Analysis of variance statistics on difference between the performance of students taught Chemistry using laboratory, discussion andconventional methods

ANOVA Performance	Sum of Squares	Df	Mean Square	F-ratio	F-crit	P
Between Groups	32315.785	2	657.893	35.793	3.0	0.010
Within Groups	9816.195	204	48.119			
Total	42131.981	206				

Table 20 showed the f-ratio value of 35.793 at 204 degree of freedom at 0.05 level of significance. The critical value of 3.000 is less than f-ratio value 35.793 at df 2, the probability level of significance p0.010< 0.05. This means that significant difference existed in the performance of students taught Chemistry using laboratory, discussion and conventional methods, thus the null hypothesis five which States that there is no significant difference between the performance of students taught Chemistry using laboratory, discussion and conventional methods was rejected.The source of difference is explained in table 21

Table 21 Summary of Post Hoc Scheffe Multiple Comparison Mean test on difference in the performance of students taught Chemistry using laboratory, discussion and conventional method

Methods	Conventional	Discussion	Laboratory
Conventional	1	-2.56	-29.76
Discussion	2.56	1	-27.19
Laboratory	29.76	27.19	1

Table 21showed that there was difference between the performance of students taught Chemistry using laboratory, discussion and those taught with conventional method. The area of the difference lies with the students taught Chemistry using laboratory method as they performed better than those taught using discussion and conventional methods.

Hypothesis Six: There is no significant difference in the retention ability of students taught Chemistry using laboratory, discussion andthose taught with the conventional method in SeniorSecondary Schools in Kaduna State, Nigeria

The data collected through the administration of the instrument titled Chemistry Student Performance and Retention Test (CSPART) was analyzedusing Analysis of variance (ANOVA)

Table 22: Summary of Analysis of variance statistics on difference in the Retention ability of studenttaught Chemistry using laboratory, discussion and conventional method

ANOVA Retention	Sum of Squares	Df	Mean Square	F-ratio	F-crit	P
Between Groups	46337.056	2	231.528	507.342	3.000	.000
Within Groups	9315.968	204	45.667			

Total	55653.024	206

Table 22 showed the f-ratio value of 507.342 at 204 degree of freedom at 0.05 level of significance. The critical value of 3.000 is less than f-ratio value 507.342 at df 2, the probability level of significance p 0.000< 0.05. This indicates that there is significant difference between the retention ability of students taught Chemistry using laboratory, discussion and conventional methods. The implication of this result is to reject the null hypothesis which States that there is no significant difference between the retention ability of students taught Chemistry using laboratory, discussion and conventional methods. The source of difference is in table 23

Table 23: Summary of Post Hoc scheffe Mean comparison test on difference in the retention ability of students taught Chemistry using Laboratory, Discussion and conventional method

Methods	**Conventional**	**Discussion**	**Laboratory**
Conventional	1	-6.66	-36.39
Discussion	6.66	1	-29.73
Laboratory	36.39	29.73	1

Table 23 showed that there was difference in the retention ability of students taught Chemistry using laboratory, discussion and conventional method. The difference lies with the retention ability of students taught Chemistry using laboratory method as their performance was better than those taught using discussion and conventional methods

4.6 Summary of Findings

Based on the research questions and hypotheses tested, the following are the main findings:

1. Post test performance of students taught Chemistry using laboratory method was significantly higher than their pretest scores. (p-value 0.000<0.05)
2. Students taught Chemistry using discussion method performed significantly better in their post-test(p-value 0.010<0.05)
3. The use of laboratory method has significantly higher effect on the retention ability of students taught Chemistry compared to those taught with the conventional method(p-value 0.000<0.05)
4. The use of discussion method had significantly higher effect on the retention ability of students taught Chemistry compared to those taught with the conventional method. (P-value 0.001<0.05)
5. The performance of students taught Chemistry using laboratory method was significantly better than those exposed to discussion and conventional methods(p-value 0.010<0.05)
6. The retention ability of students taught Chemistry using laboratory method was significantly better than those taught using discussion andconventional methods(p-value 0.000<0.05)

4.7 Discussion on Findings

Findings number one revealed that the Post test performance of students taught Chemistry using laboratory method in SeniorSecondary Schools in Kaduna State, Nigeria was significantly higher than pre-test. Their mean Pre test and Post test scores

were 12.784 and 49.764 respectively with a mean difference of 36.980 in favour of the Post test scores. This indicates a significant positive effect of laboratory method on the students Chemistry performance. This outcome necessitated the rejection of the null hypothesis and this implied that the laboratory teaching method is a very good method that improves the performances of students in Chemistry when taught especially with qualified Chemistry teachers at the SeniorSecondary School levels. This result agrees with Tobin (2009) and Ikeobi (2010), who reported that meaningful learning is possible from given laboratory experiments, if the students are given ample opportunities to operate equipment and materials that help them to construct their knowledge of phenomena and related scientific concepts. The construction of deep scientific knowledge results from actively practicing science in structured learning environments, that is, where the nature of laboratory activities are taken into consideration. Contrary to the findings of this study, Ugan (2019) established that students performed better when taught with cooperative learning strategy than the laboratory and conventional methods in Secondary Schools in Jigawa State.

The second finding showed that post test performance of students taught Chemistry using discussion method in SeniorSecondary Schools in Kaduna State, Nigeria, was significantly higher. Their mean Pre-test and Post test scores were 11.622 and 22.566 respectively with a mean difference of 10.943 in favour of the Post test scores. This indicates a significant positive effect of discussion method on the Chemistry students' performance. The fact that the post test was higher than the pre test after the exposure of the students to the discussion method shows that the discussion method is effective in the teaching of Chemistry in the SeniorSecondary School level. The

outcome was in agreement with Johnston, Anderman, Milne & Harris, Tharp & Gallimore, cited in Larson, (2010) who all agreed that discussion is thought to be a useful teaching method for developing higher-order thinking skills; skills that enable students to interpret, analyze, and manipulate information. Students explain their ideas and thoughts, rather than merely recounting or reciting memorized facts and details. During discussion, learners are not passive recipients of information that is transmitted from a teacher. Rather, learners are active participants. As they interact during the discussion, students construct an understanding about the topic and result in higher academic performance. Also, Sanda and Mazila, (2017) supported the claim in their study that discussion method significantly improved the post-test performance of students. But on the contrary, Ogbeba (2013) found that students taught using laboratory method achieved significantly higher than those taught using discussion method.

The third finding revealed that students taught Chemistry using Laboratory method had significantly higher retention ability compared to those taught with the lecture or conventional method in SeniorSecondary Schools in Kaduna State, Nigeria. Their mean retention ability scores were 51.019 and 14.621 by students taught Chemistry using Laboratory method and those taught with the lecture conventional method respectively with a mean difference of 36.39 in favour of students taught Chemistry using Laboratory method. This indicates a significant positive effect of laboratory method on the students Chemistry performance as compared to those taught with conventional teaching method. This is in agreement with Goje, (2014) whose study investigated the effects of laboratory teaching and lecture method on academic achievement and attitude to acid and base concepts in Chemistry among

SeniorSecondary School students in Kaduna State, Nigeria. The study recommended among others that Chemistry teachers should use laboratory-based method as a common method of teaching in order to enhance students' performance in Chemistry. This claim was contradicted with the finding of Namasaka, Mondoh and Wasike, (2017) who reported that for students to retain learnt information, a sequential teaching method that combines different methods of teaching should be used.

The fourth finding showed that the retention ability of students taught Chemistry using discussion method was significantly higher than those taught with the conventional method in SeniorSecondary Schools in Kaduna State, Nigeria. The retention ability mean scores were 21.283 and 14.621 respectively with a mean difference of 6.661 in favor of students taught Chemistry using discussion method. These indicate that the retention ability of students taught Chemistry using discussion method was higher at the post-post-test. Therefore, the null hypothesis four was thus rejected because there was significant difference in the retention ability of students taught Chemistry using discussion method when compared to those taught with the conventional method in SeniorSecondary Schools in Kaduna State, Nigeria. This finding agrees with the report of Rahman, Khalil, Jumani, Ajmal, Malik and Sharif (2011), that discussion method enhances students performance and it is a good and effective teaching method over the conventional teaching method.

The fifth finding showed that significant difference existed in the performance of students taught Chemistry using Laboratory, Discussion and conventional method in SeniorSecondary Schools in Kaduna State, Nigeria. Their computed mean performances

were 49.7647, 22.5660 and 20.0000 by students taught Chemistry respectively. This indicated a significantly greater effect of laboratory method over discussion and conventional teaching methods.

This means that there was significant difference between the performance of students taught Chemistry using laboratory and discussion methods as compared with conventional methods. This necessitated the rejection of the null hypothesis which States that there is no significant difference in the performance of students taught Chemistry using laboratory, discussion and conventional methods in SeniorSecondary Schools in Kaduna State, Nigeria. This agrees with Adewuya as cited in Yusuf, (2016) who believed that some of the advantages of practical activities and discussion method are sharing of ideas by students, development of social skills of talking and listening, clarification of ideas and promotion of team work. In the same vein, according to Stephen and Stephen in Yusuf (2016), discussion is a process of giving and taking, speaking and listening, describing and witnessing which helps expand horizons and foster mutual understanding. They explained further that it is only through discussion that one can be exposed to new points of view and exposure increases understanding and renews motivation to continue learning. Yusuf, Guga and Ibrahim (2016), noted that discussion is concerned with the development of knowledge, understanding or judgment among those people taking part in it. They believed that discussion is more serious than conversation.

Outcome of question six and hypothesis revealed that significant difference existed in the performance of students taught Chemistry using laboratory, discussion and those taught with the conventional method in SeniorSecondary Schools in Kaduna

State, Nigeria. Their computed mean statistics on their performances were 51.0196, 21.2830 and 14.6214 by students taught Chemistry using laboratory, discussion and those taught with the conventional method respectively This showed that the students of Experimental 1 (Lab Method) had the highest mean performance followed by those of Experimental II (Discussion Method, and least were those of control (conventional) method.

This completely agrees with Yusuf, (2012) who cited some advantages of laboratory teaching method over the conventional method to include but not limited to the followings: laboratory method makes the students learn about the nature of science and technology thereby enhancing the student's interest and sharpening his/her understanding, laboratory method enhances the ability of students to transfer skills to solve other problems, laboratory method has the potential of stimulating ma lifetime interest in science in the students. Through laboratory method, students develop scientific attitude and character which include: curiosity, open mindedness, objectivity, honesty, reverence for life, rationality. In addition, it affords the students opportunity to develop manipulative skills through several attempts and trials in the laboratory. Laboratory method gives students opportunities to gain exposure to facts of scientific phenomena which aid retention of information and getting results, laboratory sharpens the students' mind and enhances the development of self-confidence. Consequently this null hypothesis was rejected. This outcome is interesting as it showed that among the three teaching methods the laboratory teaching method is the best option compared with other two methods. This outcome was confirmed by Hass in Kwabena (2013) who opined that the laboratory is an ideal environment for both active and cooperative

engagement. A further enhancement of the laboratory experience can be by encouraging students to interact with each other during the practical activity process.

CHAPTER FIVE
SUMMARY, CONCLUSION, AND RECEOMMDNATIONS

5.1 Summary

The study evaluated the Effects of Laboratory and Discussion Methods on Students' Performance and Retention inChemistry in SeniorSecondary Schools, Kaduna State, Nigeria. The study was carried out with six objectives which were to: determine the pre-test and post-test performance of Chemistry students taught using laboratory method in SeniorSecondary Schools in Kaduna State, Nigeria; examine of the pre-test and post-test performance of Chemistry students taught using discussion method in Senior Secondary in Schools in Kaduna State, Nigeria; determine the effect of laboratory method and conventional method on students retention ability in Chemistry in SeniorSecondary Schools in Kaduna State, Nigeria; determine the effect of discussion method and conventional method on Students retention in Chemistry in SeniorSecondary Schools in Kaduna State, Nigeria; compare the performance of Chemistry students exposed to laboratory, discussion and conventional methods in SeniorSecondary Schools in Kaduna State, Nigeria and compare the retention ability of students taught Chemistry with laboratory, discussion and conventional methods in SeniorSecondary Schools in Kaduna State, Nigeria. In line with the stated objectives, six corresponding research questions and hypotheses were formulated.

The research was conducted using using-experimental design. The target population of the study comprised eighteen thousand one hundred and thirty eight (18,138) Chemistry students in the twelve (12) educationalzones of Kaduna State. The sample size for this study consisted of two hundred and seven SSII Chemistry students

across Zaria educational zone of Kaduna State. The instrument tagged “Chemistry Students’ Performance and Retention Test (CSPRT)” was used for the purpose of data collection. The validated instrument was pilot tested and data collected were analysed using Pearson Product Moment Correlation Co-efficient (PPMCC), hence, a reliability coefficient of 0.75 was obtained.Data were collected through the administration of pre-test, post-test and retention–test. The demographic data of the respondents was analysed using descriptive statistics which involved frequencies and percentages while mean, standard deviation and standard error mean were used to answer the research question. Paired sample t-test, independent t-test and one way analysis of variance (ANOVA) were used to test the hypotheses advanced for the study at 0.05 level of significance.

Findings from the study revealed that the posttest performance of students taught Chemistry using laboratory methodsignificantly improved over the pretest score, similarly, the posttest score of students taught Chemistry using the discussion method was higher than their pretest scores. Students taught Chemistry using laboratory method significantly scored high marks after teaching and learning have taken place than their counterparts taught using conventional method. The retention rate of students taught Chemistry using conventional method declined fast as compared to their counter parts using laboratory method which retained the concept taught longer. Students taught Chemistry using discussion method performed significantly better than their counterparts taught with conventional method. Students taught Chemistry using discussion method retained the concepts taught longer than their counterparts taught using conventional method. The performance of students taught Chemistry using laboratory method was significantly better than those taught using discussion and

conventional methods. Lastly, the retention ability of students taught Chemistry using laboratory method was better than those taught using discussion and conventional methods.

5.2 Conclusion

On the basis of the findings from the study, it was concluded that laboratory teaching method motivates students to actively participate in the learning experience rather than sit and be passive recipient of information. In like manner, it was concluded that discussion method enables students to discuss and share ideas related toChemistry with other students and when students were exposed to discussion method, they had better performance than their counterparts taught using conventional method in SeniorSecondary Schools in Kaduna State.It was also concluded that experiment 1 (laboratory teaching method) is a better method of improving the performance and retention ability of SeniorSecondary School students in Chemistry when compared to either discussion and conventional method of teaching.

5.3 Recommendations

The following basic recommendations based on the outcome of the analysis have been put forward:

1. The laboratory method of teaching should be emphasized in the teaching of Chemistry ahead of other teaching methods for tangible results and teachers should be encouraged to actively involve students into relevant participatory laboratory activities since it has been found to improve performance in Chemistry

2. Chemistry teachers at Secondary School level should be given adequate encouragement and motivational resources such as sponsorship to attend seminars, workshops and in service trainings for capacity building.
3. Students need to be intrinsically and extrinsically motivated in Chemistry through award of prices and scholarship to high excellent students in Chemistry performance and retention ability.
4. School authority should provide all the necessary facilities needed in Chemistry laboratories for effective teaching of the subject at the SeniorSecondary Schools in Kaduna State.
5. For effective realization of the outcome of discussion method, the teacher should be fully involved and not leaving only the students to do the discussion by themselves or with only their peer groups or friends as the method enhances students participation by contributing problems, developing the factors associated with the problem, placing the solution into actions and evaluating the result. More so, students' listening skill can be enhanced.
6. Government, curriculum planners, quality assurance authorities, school managers and teachers of Chemistry should promote and accord high priority and the integration of both laboratory and discussion methods into teaching and learning of Chemistry so as to provide students with adequate skills capable of improving their performance for effective Chemistry curriculum delivery.

5.4Contributions to Knowledge

1. This studestablished that, laboratory and discussion methods of teaching Chemistryturned students from passive information recipient to active, free self-

learner and problem solvers, and slides the emphasis of educational programmes from teaching to learning.

2. Laboratory method of teaching Chemistry exposed students to practical aspects of learning which enhanced their performance by presenting suitable practicals that were adequate to the level of learners understanding and development.

3. This study has widened the scope of knowledge on issues involving practical experience gained from the study as students were able to develop participatory decision making, analytical, leadership and active citizenship skills for realizing personal responsibility as citizens. It has similarly revealed some attitudes of students in relation to such areas as social skill, group work, communication, information acquisition and information sharing with others that were affected positively.

4. Finally, the study also contributed to knowledge by generating an ideal situation for teaching Chemistry because learners were involved actively on hands and mind experiences, where they acquired opportunities and related concepts and theories with actual observations.

5.5 Suggestions for further studies

The study which was basically on the "evaluation of the effects of laboratory discussion method on the performances and retention ofChemistry students inSeniorSecondary Schools in Kaduna State, Nigeria" can be further studied in the following ways:

1. Implementation of Chemistry curriculum through effective use of teaching methods in SeniorSecondary Schools in Kaduna State.

2. Comparative effects of peer group tutoring and lecture teaching methods on the academic achievement of Chemistry students in Senior secondary schools in Kaduna State, Nigeria
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APENDIX A

REQUEST LETTER

CHEMISTRY STUDENTS PERFORMANCE AND RETENTION TEST (CSPRT)

Time allowed: 1hour

Dear Respondents,

The research instrument is meant for you to attempt the questions. Your honest response will help in uplifting the standard of Chemistry education in the State. The result is not part of the requirements for the award of a Ph.D degree in Curriculum and Instruction, Ahmadu Bello University, Zaria

Thank you.

Lucy Omoka Adejo
P16EDFC9026

APPENDIX B

RESEARCH INSTRUMENT

CHEMISTRY STUDENTS PERFORMANCE AND RETENTION TEST (CSPART)

Personal Data

Instruction: Fill and circle the correct option (s) in the questions below

Name of school: _____

Name of student: _____

Class: _____

Sex: _____

1.Hardness of water is due to the presence of salts of
a)Potassium
b)Chlorine
c)Magnesium
d)Boron

2.Select the incorrect Statement from the following option.
a) Water which does not form with soap and forms white scum is called hard water
b) Hard water contains dissolved calcium and magnesium salts in it
c) In hard water, cleansing quality of soap is depressed
d) Due to the presence of dissolved hardness-producing salts, the boiling point of water is depressed

3. Select the incorrect Statement from the following option.
a) Permanent hardness is due to dissolved chlorides and sulphates of calcium and magnesium
b)permanent hardness can be removed by mere boiling of water
c)water hardness is also known as non-alkaline hardness

d) The difference between the total hardness and the alkaline hardness gives the non-alkaline hardness

4. Alkaline hardness is due to the presence of bicarbonate, carbonate and hydroxides of the hardness-producing metal ions.
a) True
b) False

5. Select the incorrect Statement from the following option.
a) The taste of hard water is better than soft water
b) The dissolved calcium in hard water can help to produce strong teeth
c) Hard water coats the lead piping with a layer of insoluble calcium carbonate which prevents poisonous lead dissolving in water
d) Boiler feed water should also be hard in nature

6. Hardness of water is conventionally expressed in terms of equivalent amount of
a) H_2CO_3
b) $MgCO_3$
c) $CaCO_3$
d) $Na_2\ CO_3$

7. The chemical equivalent of $MgSO_4$ salt is
a) 60
b) 47.5
c) 82
d) 68

8. Which of the following is not a unit of hardness?
a) Parts per million
b) Degree centigrade
c) Degree clarke
d) Degree French

9. 1 degree Clarke = 1 part of $CaCO_3$ per _____ parts of water.
a) 10,000
b) 30,000
c) 50,000
d) 70,000

10. 1 ppm =
a) 0.07 ^{0}Fr

b) 0.7^0Fr
c) 0.1^0Fr
d) 0.01^0Fr

11. Sublimation, dissolving and filtration can only be carried out in
a) soluble-substances in solution
b) insoluble substances in liquids
c) liquid-liquid mixtures
d) solid-solid mixtures

12 Process quicker than filtration but not so effective is
a) decanting
b) centrifuging
c) crystallization
d) fractional distillation

13 Crystallization is used to
a) purify sugar
b) purify fertilizers
c) separate salt from solution
d) Both A and B

14 Anhydrous agent used to remove water from ethanol distillate may be
a) iodine
b) hydrocarbon
c) calcium chloride
d) naphthalene

15. Only one type of atom is found in
a) organic compounds
b) inorganic compounds
c) pure substances
d) radioactive substances

16.Fluoride is also added to water, which helps in preventing
a) infection
b) sickness
c) fever
d) tooth decay

17. An addition of small dose of chlorine gas to filtered water is known as
a) coagulation
b) sedimentation
c) filtration
d) chlorination

18. Process in which water is passed through filter beds of sand and gravel to remove smaller particles of dust is called
a) coagulation
b) sedimentation
c) filtration
d) chlorination

19. Distillate formed after distillation is
a) a diluted solution
b) may contain impurities
c) a condensed solution
d) a concentrated solution

20. In vacuum distillation, substance boils at
a) its exact temperature
b) a temperature slightly above its boiling point
c) a temperature below its boiling point
d) under high pressures

21. Unit for solubility of a substance commonly used is
a) g/100g of solute
b) g/100dm_3 of solvent
c) g/100cm_3 of solvent
d) g/100g of solvent

22. Slope of graph for reactants or products at beginning of reaction is
a) Specific rate constant
b) smaller
c) slowest step
d) steepest

23. Shape of p-subshell is
a) spherical
b) dumb-bell
c) complicated
d) planar

24. Amount of carbon dioxide in atmosphere
a) 29%
b) 79%
c) 21%
d) 0.30%

25. Basic solutions have pH value
a) less than 7
b) more than 7

c) equal to 7
d) equal to 14

26. In order for a solution to be an electrolyte, the solute must
a) be a molecular compound.
b) restrict the flow of electricity
C) create a saturated solution.
d) consist of positive and negative ions.

27. Which Statement best describes a supersaturated solution? A solution which -
a) contains more solute than is normally possible.
b) has equal amounts of solute and solvent.
c) could possibly dissolve more solute.
d) has dissolved the maximum amount of solute.

28. 15 g of sugar cubes are dissolved in 120 g of water at 20^{o} C. What could be done to increase the rate of dissolution?
a) use larger sugar cubes
b) stir the mixture
c) cool down the water
d) add an electrolyte to the water

29. Which method below will *not* speed up the rate of salt dissolving in water?
a) Increasing the surface area of the solute
b) decreasing the temperature of the solvent
c) stirring the solute into the solvent
d) heating the solvent before adding the solute

30. At what temperature does 30 g of KCl dissolved in 100 g of water to create a saturated solution?
a) 10 degrees C
b) 20 degrees C
c) 30 degrees C
d) 40 degrees C

31. At what temperature would carbon dioxide gas, CO2(g), be most soluble in 100 g of water?
a) 10 degrees C
b) 25 degrees C
c) 80 degrees C
d) 100 degrees C

32. Which of the following will dissolve at the fastest rate?
a) 15 g of sugar cubes in 120 g of water at 60o C.
b) 15 g of sugar cubes in 120 g of water at 20o C.

c) 15 g of granulated sugar in 120 g of water at 60o C.
d) 15 g of granulated sugar in 120 g of water at 20o C.

33. Which of the following is FALSE Statement about water:
a) water is a polar molecule
b) more than 50% of our bodies are composed of water
c) water is a non-polar molecule
d) all of the above Statements are false

34. Water molecules form hydrogen bonds by:
a) the attraction between the positive poles of one water molecule with the negative poles of another
b) the sharing of electrons between one water molecule and another
c) the transfer of electrons between one water molecule and another
d) water molecules never form hydrogen bonds

35. Which of the following is FALSE Statement about water:
a) water is a polar molecule
b) more than 50% of our bodies are composed of water
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36. Water molecules form hydrogen bonds by:
a) the attraction between the positive poles of one water molecule with the negative poles of another
b) the sharing of electrons between one water molecule and another
c) the transfer of electrons between one water molecule and another
d) water molecules never form hydrogen bonds.

37. _____ is the attraction between molecules of the same substance:
a) adhesion
b) covalent bonding
c) cohesion
d) ionic bonding

38. _____ is the attraction between molecules of different substances:
a) adhesion
b) covalent bonding
c) cohesion
d) ionic bonding

39. The high heat capacity of water allows it to:
a) form additional hydrogen bonds
b) absorb large amounts of heat energy before the temperature changes
c) boil at higher temperatures than many liquids
d) B and C

40. In a solution of salt dissolved in water, the water is acting as the _____ and the salt is the _____.
a) solute, solvent
b) solvent, solute
c) solvent, solution
d) solution, solute

41. Which of the following is a mixture?
a) salt and pepper combined in a bowl
b) salt dissolved in a glass of water
c) sugar dissolved in a mug of tea
d) all of the above

42. Which of the following is a solution?
a) salt dissolved in a tub of warm water
b) powdered lemonade mix stirred into a pitcher of water
c) sugar dissolved in a mug of hot water
d) all of the above
43. Why is water such a good solvent?
a) because it is polar
b) because it is liquid
c) because of its high specific heat capacity
d) because of its low specific heat capacity

44. Mixtures of water and non-dissolved material are called _____.
a) ionic solutions
b) covalent solutions
c) suspensions
d) covalent mixtures

45. Pure water has a pH of _____.
a) 5
b) 6
c) 7
d) none of the above

46. The pH scale ranges from 1-14; a lower number on the pH scale would indicate _____ acidity than a higher number.
a) lower
b) higher
c) pH does not have to do with acidity
d) equal

47.Water is a
a) polar solvent

b) non polar solvent
c) an amphipathetic solvent
d) non polar uncharged solvent

48. Most important reason for the unusual properties of water is:
a) the covalent bonding pattern in water molecule
b) the bond angle between the two hydrogen atoms in water
c) hydrogen bonding between water molecules
d) water can be immediately ionized at room temperature

49. The H-O-H bond angle in water molecule is:
a) 104.00
b) 104.50
c) 105.00
d) 105.50

50. Which of the following Statement is true regarding the electronegativity of atoms in water molecule
a) hydrogen is more electronegative than oxygen
b) hydrogen is less electronegative than oxygen
c) electronegativity of hydrogen and oxygen is more
d) oxygen and hydrogen do not have significant electronegativity in water

APPENDIX C

LESSON UNITS

Theme: Chemistry and Environment

1. Concept and structure of Water

2. Solubility

3. Factors affecting solubility

4. Hardness and removal of Water hardness

5. Production of distilled Water

APPENDIXD

LESSON PLANS FOR EXPERIMENTAL GROUP I (LABORATORY METHOD)

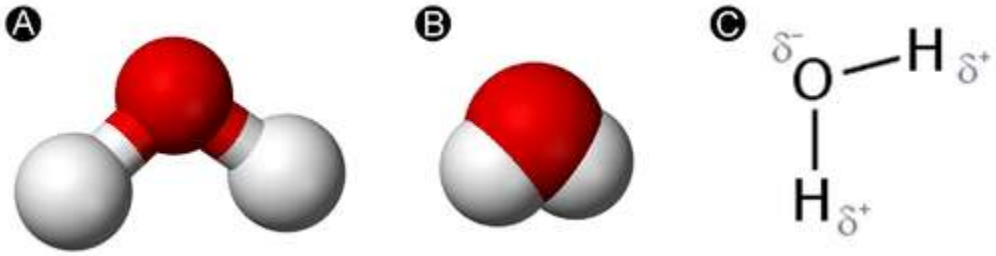
The laboratory method is a teaching method whereby learners are actively engaged in the learning process rather than absorbing lectures and listening to lessons only. This is one of theimportant methods of teaching science and it forms an integral part of effective science teaching. Under this method, teacher encourages the students to derive various scientific laws and principles on their own by getting personally involved in the experiment work. For this method to be effective, provision of a well equipped laboratory is required. The laboratory method is a planned learning activity dealing with original or raw data in the solution of problem. The laboratory method is used to designate a teaching procedure in the physical sciences that uses experimentation with apparatus.

WEEK ONE LESSON PLAN FOR EXPERIMENTAL GROUP I

(LABORATORY METHOD)

School-	Barewa College
Date-	Wed 25th Sep, 2019
Class-	SSII
Average age of students-	15 years
Period-	1st
Duration-	40mins
Subject-	Chemistry
Topic-	Chemistry and Environment
Sub-topic-	Water
Instructional materials-	Water and chart of water structure
Behavioral objectives-	By the end of the laboratory activities, students should be able to: 1. define water 2. draw the structure of water 3. explain the structure of water
Previous Knowledge	The students make use of water
Introduction	The lesson was introduced by asking the students' questions based on their previous knowledge e.g describe water?
Presentation	The teacher presented the lesson in the following steps:
Step 1	**S**tudents were led to the Chemistry laboratory by the teacher
Step 2	Bowls of water sample were kept by students with the directive of the teacher at various points where students were grouped.
Step 3	The concept of water was clearly defined by the teacher: Water is a substance that is colorless, tasteless and odorless.
Step 4	Chart of water structure was displayed by the teacher for students' observation

THE STRUCTURE OF WATER



Step 5 The teacher explained the structure of water: The structure of water Varies considerably depending on its physical State. It is rich in oxygen and bounded by two hydrogen molecules as seen represented in the chart

Students grouping In carrying out laboratory activities, students were paired up into a small group for easier handling of the laboratory activities after which each group appointed a leader, secretary and time keeper among its members.

Rules for students to follow

Students within the groups should:

i. cooperate andwork hard each in the laboratory.

ii. respect opinion of every group member for peaceful coexistence.

iii. be punctual and be in constant attendance.

Various group tasks

The groups were assigned the tasks of observing, defining, drawing and explaining the structure of water. The students observed, jotted down points and by the end, each group reconciled the points for final presentation to the entire class through their representatives.

Teacher's role in the laboratory

The teacher moved from one group to the other, watch the trend of what is being observed in each group. Teacher gives suggestions and encourages them to work as a team for the success

of the group because the success of every group depends on the individual's cooperation and participation. The teacher also has the duty of informing the groups on the time to end the activity and when to compile their summary of points for presentation.

Culminating Activities: The teacher/researcher coordinates and encourages the various groups to : write, organize, compile and present their report to the entire class regarding the areas assigned to them via the group secretary or chairman.

Evaluation Activities

This is a time when the teacher calls for the class members to deliberate on the various reports. Each group will present its report on the task assigned to them through the secretary and the chairman to the entire class. The teacher will listen and assess the extent of their presentation. Final report serves as the reference point for the members of the class. Finally, the teacher encourages students to share all that they have practicalized in their various groups by asking them the following questions:

1. Define water
2. Draw the structure of water.
3. Explain the structure of water

Conclusion

Students were asked to draw the structure of water

WEEK TWO LESSON PLAN FOR EXPERIMENTAL GROUP I

(LABORATORY METHOD)

School-	Barewa College
Date-	Wed 2nd Oct, 2019
Class-	SSII
Average age of students-	15 years
Period-	1st
Duration-	40mins
Subject-	Chemistry
Topic-	Chemistry and Environment
Sub-topic-	Types, sources and uses of water
Instructional materials-	Diagrames on cardboard paper, washing soda, samples of water from borehole and well, pieces of cloths
Behavioural objectives-	By the end of the laboratory activities, students should be able to: 1. list the types of water 2. mention the sources of water 3. explain the uses of water
Previous Knowledge	Students have learnt the concept of water in their last lesson
Introduction	The teacher introduces the lesson by asking the students' questions based on their previous knowledge e.g Define water
Presentation	The lesson will be presented in the following steps:
Step 1	Students were led to the laboratory
Step 2	The teacher lists the types of water as: Hard water and soft water are the basic types of water we have. Samples of hard water and soft water will be displayed by the teacher for observations. Hard water is salty in nature and difficult to form with soap while soft water is not salty and easy to foam with soap.
Step 3	Chart of different sources of water were displayed by the teacher for students' observation. The teacher listed some sources of water such as tap water, well water borehole etc Hard water are water obtained from the sources such as lake, ponds while soft

	water is obtained as a result of digging deep the ground into rocks inform of borehole water.
Step 4	Students used washing soda and pieces of cloths at each group to wash in the different water samples and observe clearly the differences.
Step 5	Explanation on the uses of water with the help of the teacher was given, Water can be used for various purposes especially for: **.**drinking, cooking, generating electricity at high water fall, washing and e.t.c
Students grouping	The entire students were paired up into a small group to observe and share their ideas on the types, sources and uses of water after which each group appointed a leader, secretary and time keeper among its members.

Rules for students to follow

Students within the groups should:

i. observe and share their ideas

ii. respect the views expressed by other members of the group for peaceful coexistence.

iii. draw conclusions based on their obsrvation.

Various group task

The entire group was assigned the tasks of identifying the types, sources and uses of water. The students were engaged in observing, jotting down points and by the end, each group reconciled the points for final presentation to the entire class through group representatives.

Teacher's role in the laboratory activities

The teacher moved from one group to the other, watch the trend of what was being observed and demonstrated by the students in each group, gave suggestions and encouraged them to workas a team for the success of the group because the success of every group depends on the individual's cooperation and participation. The teacher also has the duty of informing the groupson the time to end the demonstration and when to compile their summary of points for presentation.

Culminating Activities

1. The teacher/researcher coordinate and encourage the various groups to : write, organize, compile and present their report to the entire class regarding the areas assigned to them via the group secretary or chairman.

Evaluation Activities This is a time when the teacher calls for the class members to deliberate on the various reports. Each group will present its report on the task assigned to them through the secretary and the chairman to the entire class. The teacher will listen and assess the extent of their presentation. Final report serves as the reference point for the members of the class. Finally, the teacher encourages students to share all that they have discussed in their various groups by asking them the following questions:

1. list the types of water
2. mention the sources of water
3. explain the uses of water

Conclusion Students were asked to list and explain the properties of water

WEEK THREE LESSON PLAN FOR EXPERIMENTAL GROUP I

(LABORATORY METHOD)

School-	Barewa College
Date-	Wed 9th Oct, 2019
Class-	SSII
Average age of students-	15 years
Period-	1st
Duration-	40mins
Subject-	Chemistry
Topic-	Chemistry and Environment
Sub-topic-	Solubility of substances
Instructional materials-	Salt, sugar, and water
Behavioural objectives-	By the end of the laboratory activities, students should be able to: 1. define solubility 2. State the rules of solubility in water 3. carry out activities using salt, sugar and water to determine the solubility of a substance.
Previous Knowledge	Students are familiar with sand, salt, water
Introduction	The lesson was introduced by the teacher asking the students questions based on their previous knowledge e.g what are the uses of salt and water?
Presentation	The following steps were used in presenting the lesson:
Step 1	Solubility is the ability to dissolve a substance especially in a liquid. As the temperature increases the solubility of the gas generally decreases
Step 2	The rules for solubility are staed as follows:

Solubility Rules

The following are the solubility rules for common ionic solids. If two rules appear to contradict each other, the preceding rule takes precedence.

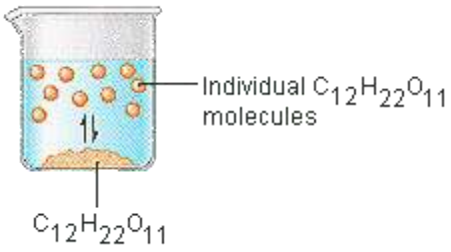
1. Salts containing Group I elements (Li^+, Na^+, K^+, Cs^+, Rb^+) are soluble . There are few exceptions to this rule. Salts containing the ammonium ion (NH_4^+) are also soluble.

2. Salts containing nitrate ion (NO_3^-) are generally soluble.
3. Salts containing Cl^-, Br^-, or I^- are generally soluble. Important exceptions to this rule are halide salts of Ag^+, Pb^{2+}, and $(Hg_2)^{2+}$. Thus, AgCl, $PbBr_2$, and Hg_2Cl_2 are insoluble.
4. Most silver salts are insoluble. $AgNO_3$ and $Ag(C_2H_3O_2)$ are common soluble salts of silver; virtually all others are insoluble.
5. Most sulfate salts are soluble. Important exceptions to this rule include $CaSO_4$, $BaSO_4$, $PbSO_4$, Ag_2SO_4 and $SrSO_4$.
6. Most hydroxide salts are only slightly soluble. Hydroxide salts of Group I elements are soluble. Hydroxide salts of Group II elements (Ca, Sr, and Ba) are slightly soluble. Hydroxide salts of transition metals and Al^{3+} are insoluble. Thus, $Fe(OH)_3$, $Al(OH)_3$, $Co(OH)_2$ are not soluble.
7. Most sulfides of transition metals are highly insoluble, including CdS, FeS, ZnS, and Ag_2S. Arsenic, antimony, bismuth, and lead sulfides are also insoluble.
8. Carbonates are frequently insoluble. Group II carbonates ($CaCO_3$, $SrCO_3$, and $BaCO_3$) are insoluble, as are $FeCO_3$ and $PbCO_3$.
9. Chromates are frequently insoluble. Examples include $PbCrO_4$ and $BaCrO_4$.
10. Phosphates such as $Ca_3(PO_4)_2$ and Ag_3PO_4 are frequently insoluble.
11. Fluorides such as BaF_2, MgF_2, and PbF_2 are frequently insoluble.

Step 3

Using water, sugar and salt, the students will be led to carry out activities. Students will be instructed to measure a table spoon of sugar, a table spoon of salt and dissolve in a measured quantity of water for observations. Amount of a substance (called the solute) that dissolves in a unit volume of a liquid substance (called the solvent) to form a saturated solution under specified conditions of temperature and pressure. Solubility is expressed usually as moles of solute per 100 grams of solvent.Solublesubstances are those that easily dissolve in a solvent, such as water, and include sugar, salt, alcohol and some dishwashing detergents. In Chemistry, solubility of a substance is a quantitative term that refers to the amount of substance that can dissolve in a given volume of a solvent.

Why Do Some Solids Dissolve in Water?The sugar we use to sweeten coffee or tea is a *molecular solid*, in which the individual molecules are held together by relatively weak intermolecular forces. When sugar dissolves in water, the weak bonds between the individual sucrose molecules are broken, and these $C_{12}H_{22}O_{11}$ molecules are released into solution.



It takes energy to break the bonds between the $C_{12}H_{22}O_{11}$ molecules in sucrose. It also takes energy to break the hydrogen bonds in water that must be disrupted to insert one of these sucrose molecules into solution. Sugar dissolves in water because energy is given off when the slightly polar sucrose molecules form intermolecular bonds with the polar water molecules. The weak bonds that form between the solute and the solvent compensate for the energy needed to disrupt the structure of both the pure solute and the solvent. In the case of sugar and water, this process works so well that up to 1800 grams of sucrose can dissolve in a liter of water.

Students grouping The entire students are paired up into a small group to perform experiments to prepare solutions of common substances and share their ideas after which each group will appoint a leader, secretary and time keeper among its members.

Rules for students to follow

Students within the groups must:

i. measure the right quantity of salt and sugar

ii. ensure the water is clean enough.

iii. observe the end result of the experiment carefully.

Various group task

The groups were assigned the tasks of defining solubility, stating the rules of solubility and carrying out laboratory activities with salt, sugar and water to determine their solubility. The students were engaged in demonstrating, jotting points and by the end, each group reconciled thepoints for final presentation to the entire class through group representatives.

Teacher's role in the activity

The teacher moved from one group to the other, observed the trend of what was beign experimented in each of the groups. He gives suggestions and encouraged them to work as a team for the success of the group because the success of every group depends on the individuals

cooperation and participation. The teacher also has the duty of informing the groups on the timeto end the activity and when to compile their summary of points for presentation.

Culminating Activities

1. The teacher/researcher coordinate and encourage the various groups to: write, organize, compile and present their report to the entire class regarding the areas assigned to them via the group secretary or chairman.

Evaluation Activities

This is a time when the teacher calls for the class members to deliberate on the various reports. Each group will present its report on the task assigned to them through the secretary and the chairman to the entire class. The teacher will listen and assess the extent of their presentation. Final report serves as the reference point for the members of the class. Finally, the teacher encourages students to share all that they have discussed in their various groups by asking them the following questions:

1. Define solubility

2. State the rules of solubility in water

3. Carry out activities using salt, sugar and water to determine the solubility of a substance.

Conclusion: The teacher concluded by summarizing the main points of the lesson

WEEK FOUR LESSON PLAN FOR EXPERIMENTAL GROUP I

(LABORATORY METHOD)

School-	Barewa College
Date-	Wed 16th Oct, 2019
Class-	SSII
Average age of students-	15 years
Period-	1st
Duration-	40mins
Subject-	Chemistry
Topic-	Chemistry and Environment
Sub-Topic	Solubility (Solute, solvent and solution)
Instructional materials-	Sodium chloride, water, gasoline, oil stained pieces of cloth
Behavioural objectives-	By the end of the laboratory activities, students should be able to: 1. differentiate between solute, solvent and solution 2. perform an experiment on the application of solubility in stain removal
Previous Knowledge	The students have been taught solubility of substances
Introduction	The teacher introduces the lesson by asking the students' questions based on their previous lesson e.g what is solubility?
Presentation	The presentation of the lesson followed these steps:
Step 1	Students were led to the Chemistry laboratory
Step 2	The researcher differentiated between liquid, solute and solutions: A liquid that dissolves something is called a solvent; mixtures of two or more substances are called solutions while the dissolved substance is called the solute
Step 3	Experiments were performed by each group to determine the solubility of sodium chloride and water. The students measured a quantity of sodium chloride (NaCl) and dissolve in a given quantity of water (H2O)
Step 4	The teacher writes the chemical equation of sodium chloride + water: NaCl+H2O=NaOH+Hcl

Step 5 The teacher led the students to practically apply solubility in stain removal using a piece of cloth. The students poured out a quantity of gasoline on the oil stained pieces of cloth and observed. For example, water is a good solvent for dissolving salt and sugar, however, it is not a good solvent for dissolving oil or butter. Stain removers often contain alcohol which acts as a solvent for both water-based and oil based stains.Hydrocarbon solvents, such as gasoline, may be used to dissolve some stains

Students grouping Students were paired up into a small group to experiment

Rules for students to follow

Students within the groups should:

i. follow the right procedure to achieve result

ii. work corporately for peaceful coexistence.

Various group task Groups were assigned the task to differentiate between solute, solvent, solutions and they also performed experiments on the practical application of stain removal from cloth. The students were engaged in the experiment, and by the end each group reconciled the points for final presentation to the entire class through group representatives.

Teacher's role in the activity: The teacher moved from one group to the other, observe the trend of what is being experimented in each of the groups. He gives suggestions and encourages them to work as a team. The teacher also had the duty of informing the groups on the time to end the discussion and when to compile their summary of points for presentation.

Culminating Activities

1. The teacher/researcher coordinate and encourage the various groups to write, organize, compile and present their report to the entire class regarding the areas assigned to them via the group secretary or chairman.

Evaluation Activities

This is a time when the teacher calls for the class members to deliberate on the various reports. Each group will present its report on the task assigned to them through the secretary and the chairman to the entire class. The teacher listened and assess the extent of their presentation. Final report serves as the reference point for the members of the class. Finally, the teacher encourages students to share all that they have discussed in their various groups by asking them the following questions:

1. differentiate between solute, solvent and solution

2. carry out laboratory activities on the application of solubility in stain removal

Conclusion: Students were asked to find out other solvents for stain removal

WEEK FIVE LESSON PLAN FOR EXPERIMENTAL GROUP 1

(LABORATORY METHOD)

School-	Barewa College
Date-	Wed 23rd Oct, 2019
Class-	SSII
Average age of students-	15 years
Period-	1st
Duration-	40mins
Subject-	Chemistry
Topic-	Chemistry and Enviroment
Sub-Topic	Factors affecting solubility and uses of solubility curves
Instructional materials-	Source of heat, sugar, salt, water and petric-dish

Behavioural objectives- By the end of the laboratory activities, students should be able to:

1. list the factors that affect solubility

2. explain how the factors affect solubility

3. itemize the uses of solubility curves

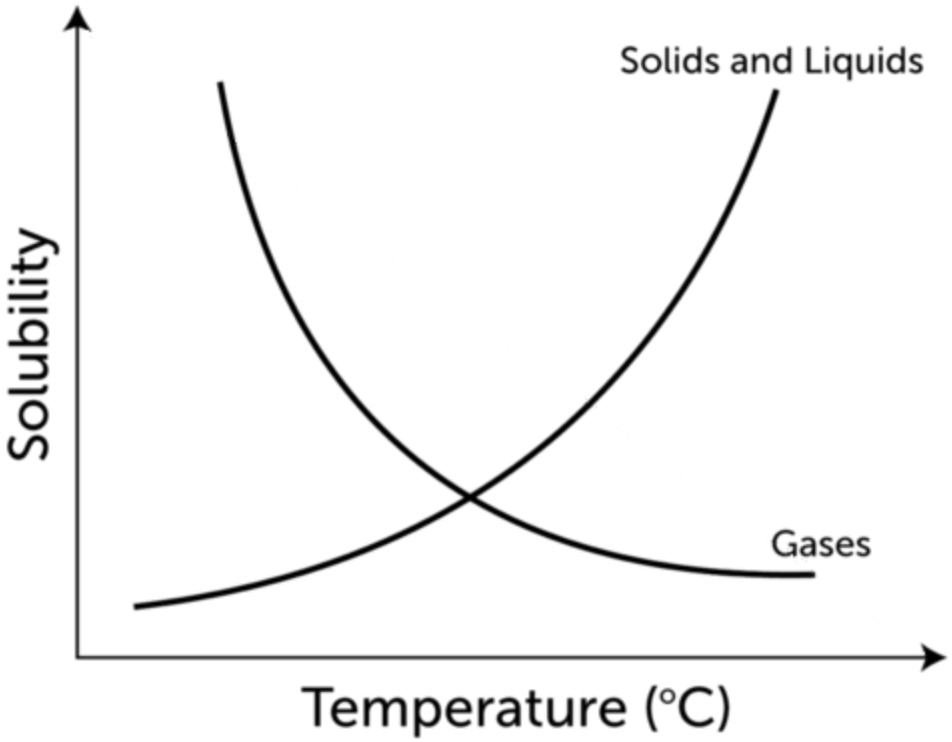
Introduction The teacher introduces the lesson by asking the students questions based on the previos lesson e.g Differentiate between solute, solvent and a solution

Presentation The following step was used for presenting the lessons:

Steps 1 Factors that can affects solubility are: Temperature and pressure.

Step 2 Solubility of solid may increase or decrease with increasing temperature and solubility of gas decreases with an increase in temperature and decrease in pressure. The teacher leads the students to dissolve some quantity of salt in water at room temperature and also put some quantity of salt in water using a petric dish and apply heat then observe which one becomes soluble faster.

Factors That Affect Solubility: Certain factors can change the solubility of a solute. Temperature is one such factor. How temperature affects solubility depends on the State of the solute, as you can see in the **Figure** below



- If a solute is a solid or liquid, increasing the temperature increases its solubility. For example, more sugar can dissolve in hot water than in cold water.
- If a solute is a gas, increasing the temperature decreases its solubility. For example, less carbon dioxide can dissolve in warm water than in cold water.

The solubility of gases is also affected by pressure. Pressure is the force pushing against a given area. Increasing the pressure on a gas increases its solubility. Did you ever open a can of soda and notice how it fizzes out of the can? Soda contains dissolved carbon dioxide. Opening the can reduces the pressure on the gas in solution, so it is less soluble. As a result, some of the carbon dioxide comes out of solution and rushes into the air.

Step 3 The teacher Itemize the uses of solubility curves

The uses of solubility curve are as follows:-

a) The shape of the curve indicates how the solubility of the given substance in a solvent varies with change in temperature.The solubility of a substance at a particular temperature can be determined from the curve.

b) The effect of cooling of hot solutions of different substances can be found from the curve

Students grouping The entire students are paired up into an experimental group to determine solubility of some substances both in room temperature and on boiling.

Rules for students to follow

Students within the groups should:

i. coperatly work together and share their ideas

ii. respect opinion of every member.

Various group tasks

All the groups will be assigned task to list and explain the factors that affect solubility, itemize the uses of the solubility curve.

Teacher's role in the activity

The teacher will move from one group to the other, listens to the trend of what is done, he gives suggestions and encourages them to work as a team for the success of the group because the success of every group depends on the individuals cooperation and participation. The teacher also has the duty of informing the groups on the time to end theexperiment and when to compile their summary of points for presentation.

Culminating Activities

1. The teacher/researcher coordinate and encourage the various groups to : write, organize, compile and present their report to the entire class via the group secretary or chairman.

Evaluation Activities

This is a time when the teacher calls for the class members to deliberate on the various reports. Each group will present its report on the task assigned to them through the secretary and the chairman to the entire class. The teacher will listen and assess the extent of their presentation. Final report serves as the reference point for the members of the class. Finally, the teacher encourages students to share all that they have discussed in their various groups by asking them the following questions:

1.list the factors that affects solubility

2. explain how these factors affect solubility.

3. mention the uses of solubility curves

Conclusion: Students were asked to find out the relationship between temperature, pressure and solubility.

WEEK SIX LESSON PLAN FOR EXPERIMENTAL GROUP I

(LABORATORY METHOD)

School-	Barewa College
Date-	30th Oct, 2019
Class-	SSII
Average age of students-	15 years
Period-	1st
Duration-	40mins
Subject-	Chemistry
Topic-	Hardness and removal of hardness in water
Instructional materials-	Washing soda, (sodium bicarbonate), filter paper, water, source of heat
Behavioural objectives-	By the end of the laboratory activities, students should be able to: 1. list types of hard water 2. discuss the causes of hardness of water 3. carry out experiments on the removal of hardness in water
Introduction	The teacher introduced the lesson by asking the students questions based on their previous knowledge e.g mention two factors that affects solubility
Presentation	Teacher presents the lesson in the following ways:
Step 1	Students will be led to the laboratory
Step 2	Types of hardness of water: Water hardness could be temporal or permanent. Hardness is as a result of the presence of bicarbonate salt, sulphate and chloride salt and can be removed by heating, treatment with soda or lime water, etc.
Step 3	Students will be led by the help of the teacher to carry outexperiments on the removal of hardness in water.
Procedure:	Take some quantity of hard water in a cornical flask, subject it to heat at boiling point, allow it to cool. Using the filter paper, filter the water carefully.**Boiling hard water** precipitates the calcium carbonate out of solution, leaving **water** that is softer when it cools. ... Both kinds of hardness, temporary and permanent, can be **removed** by installing a **water** softener, which will usually

filter out most of the **minerals** suspended in the **water**. **Boiling water** only removes some types of hardness ("temporary hardness"),

Students grouping

The entire students are paired up into groups; they set up the apparatus to demonstrate boiling of hard water. They share their ideas after which each group will appoint a leader, secretary and time keeper among its members.

Rules for students to follow

Students within the groups should:

i. demonstrate, observe and share their ideas

ii. turn of the heat source immediately after boiling.

iii. actively participate in the process

Various group task

All the group will be assigned the task of listing the types of hard water, discussing the causes ofhard water and demonstrating the practical removal of hardness in water. The students will be engaged in discussing, jotting down points and by the end, each group will reconcile the points for final presentation to be done to the entire class members through group representatives.

Teacher's role in the activity

The teacher will move from one group to the other, listens to the trend of what is beingdemonstrated in each of the groups. He gives suggestions and encourage them to work as a team for the success of the group because the success of every group depends on the individualscooperation and participation. The teacher also has the duty of informing the groups on the time to end the activity and when to compile their summary of points for presentation.

Culminating Activities

1. The teacher/researcher coordinate and encourage the various groups to : write, organize, compile and present their report to the entire class regarding the areas assigned to them via the group secretary or chairman.

Evaluation Activities

This is a time when the teacher calls for the class members to deliberate on the various reports. Each group will present its report on the task assigned to them through the secretary and the chairman to the entire class. The teacher will listen and assess the extent of their presentation. Final report serves as the reference point for the members of the class. Finally, the teacher

encourages students to share all that they have discussed in their various groups by asking them the following questions:

1. list the types of hardness of water

2. explain the causes of hardness of water

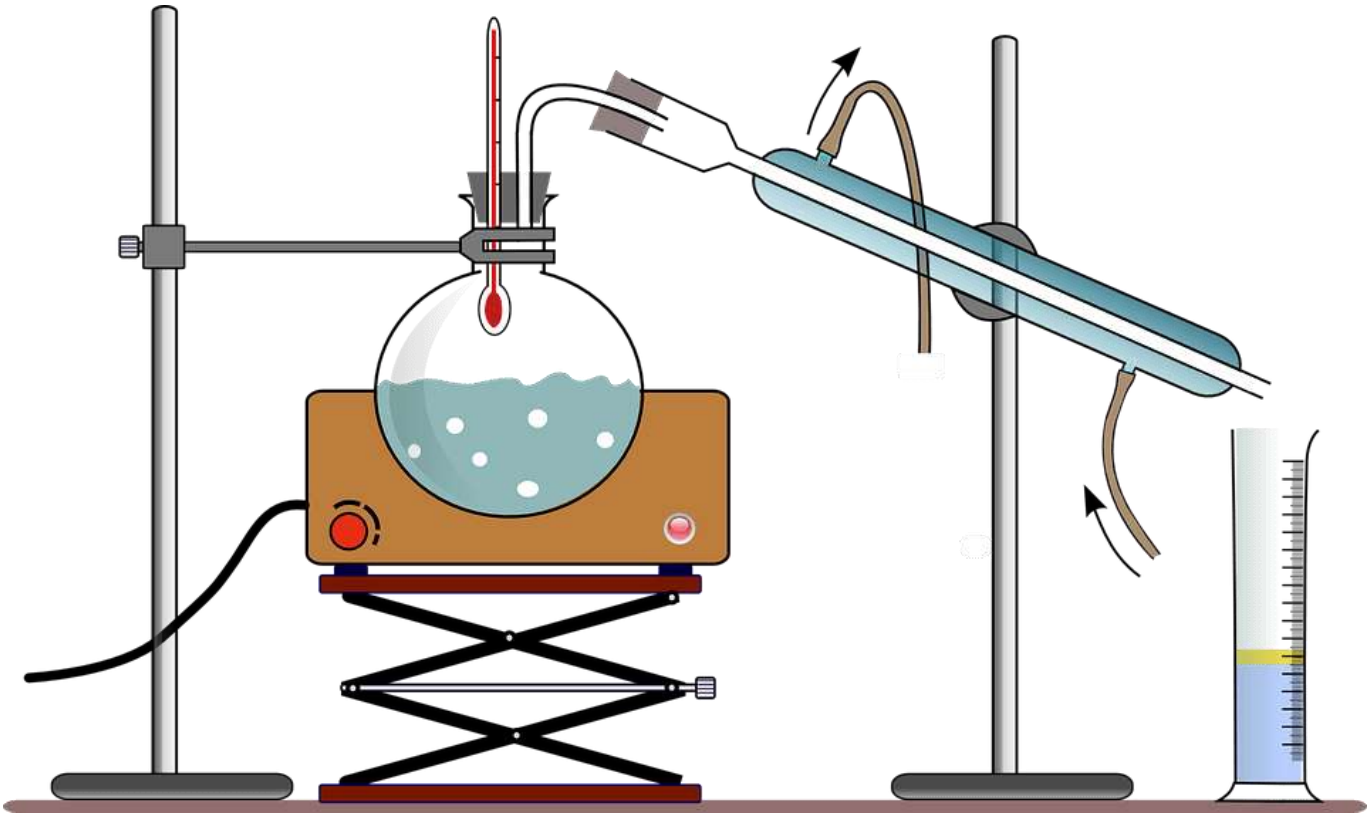
3 demonstrate the methods employed in the removal of hardness.

Conclusion: Students were asked to list two other chemicals that can cause hardness of water

WEEK SEVEN LESSON PLAN FOR EXPERIMENTAL GROUP 1

(LABORATORY METHOD)

school-	Barewa College
Date-	6th Nov, 2019
Class-	SSII
Average age of students-	15 years
Period-	1st
Duration-	40mins
Subject-	Chemistry
Topic-	Chemistry and Environment
Sub-Topic-	Production of distilled water
Instructional materials-	distillation apparatus (tripord stand, thermometer, conical flask, distillation flask), heat
Behavioural objectives-	By the end of the laboratory activities, students should be able to: 1. explain the methods used in purifying water 2. explain and draw the process of obtaining distilled water in the laboratory.
Introduction	The teacher introduces the lesson by asking the students questions based on their previous knowledge e.g List the types of harness of water learnt
Presentation	The teacher presents the lesson in the following ways:
Step 1	The teacher led the students to the laboratory
Step 2	The teacher explains purification of water as the removal of undesirable chemicals, biological contaminants, suspended solids and gases from water. Distilled water is water that has been boiled into vapor and condensed back into liquid in separate container.
Step 3	The teacher sets up the distillation apparatus and explains to the students the laboratory procedure to obtain distilled waterDistillation is very important for laboratory purposes. Distillation has been known for thousands of years. It was probably used by Arab chemists to isolate perfumes.



In modern laboratories, the process of distillation starts with heating a liquid to boil. After the liquid reaches the boiling point, the liquid evaporates, forming a gas. When the vapor cools down, the cooled gas condenses and forms a distillate. This process makes the water pure from contaminants. This process enables two liquids with different boiling points to separate cleanly.

Basic procedure of how to produce distilled water in laboratory settings:

- First, the calibration of the thermometer has to be checked by placing the thermometer in an ice bath of distilled water. The thermometer has to reach thermal equilibrium. If the measure of the temperature of the thermometer will reach more than two degrees, the thermometer has to be replaced by another and checked again.
- Second, the distillation flask is filled with no more than two-thirds full of liquid to avoid propelling the liquid to the condenser. Boiling chips should be placed in the distillation flask to prevent superheating.
- Third, the distillation flask is heated until the liquid boils and bring vapors. The vapors then eventually drip into the collection receiver. The average rate of distillation is 20 drops per minute.
- Fourth, as soon as the temperature begins to change or stabilize, there should be a collection of drops using a new receiver. The process is repeated all over again until all of the distillate has been collected in discrete functions.

- Last, before all the liquid is vaporized, the distillation flask is removed from the heat source to avoid igniting or exploding. It should be remembered that distilling to dryness is not allowed. All joints should be secured very tightly and heating in a closed system should not be done to avoid accidents

Students grouping

The entire students are paired up into a small group to observe, explain and demonstrate the process of obtaing distilled water in the laboratory. They are to share their ideas after which each group will appoint a leader, secretary and time keeper among its members.

Rules for students to follow

Students within the groups should:

i. demonstrate and share their ideas

ii. respect opinion of every group member for peaceful coexistence.

Various group task

All the groups were assigned the same task on the introduced topic. They are given the task of

explaining the methods used in purifying water, explaining and draw the process of obtaining

distilled water in the laboratory.

Teacher's role in the activity

The teacher will move from one group to the other, observe the trend of what is being

dmonstrated in each of the groups. He gives suggestions and encourages them to work as a team.

The teacher also has the duty of informing the groups on the time to end the demonstration.

Culminating Activities

1. The teacher/researcher coordinate and encourage the various groups to : write, organize, compile and present their report to the entire class regarding the areas assigned to them via the group secretary or chairman.

2. The teacher guides students as they return to their seats after the presentation.

Evaluation Activities

This is a time when the teacher calls for the class members to deliberate on the various reports. Each group will present its report on the task assigned to them through the secretary and the chairman to the entire class. The teacher will listen and assess the extent of their presentation.Final report serves as the reference point for the members of the class. Finally, the teacherencourages students to share all that they have discussed in their various groups by asking themthe following questions:

1. explain the procedure for purification of water

2. explain the production of distilled water

Conclusion: Students were asked to draw the apparatus for the process of obtaining distilled water in the laboratory

APENDIX E

LESSON PLANS FOR EXPERIMENT GROUP II (DUSCUSSION METHOD)

Discussion refers to an interactive process or a particular kind of teaching involving the teacher and the student or among the student themselves. Discussion as a teaching method leads the students into active participatory classroom learning activities. In the case of discussion, a problem or topic for the lesson is presented for discussion by the teacher, while the teacher help to direct the students views toward the objectives of the lesson. Students in the process of discussion generate varieties of ideas, which will lead to the solution of the problem while the teacher moderate. The teacher gives the students problem to solve while they carefully consider the topic, argue among them in a democratic manner, suggest solutions and draw conclusion. To make lesson for discussion method effective, attention must be given to the following aspects;

1. Encourage group discussion
2. Encourage students interaction through independent work; and
3. Encourage students to ask questions

WEEK ONE LESSON PLAN FOR EXPERIMENTAL GROUP II

(DISCUSSION METHOD)

School-	G.S.S Tudun Jukun
Date-	Mon 30th Sep, 2019
Class-	SSII
Average age of students-	15 years
Period-	3rd
Duration-	40mins
Subject-	Chemistry
Topic-	Chemistry and Environment
Sub-topic-	Water
Instructional materials-	Water and chart of water structure

Behavioural objectives- By the end of the lesson, students should be able to:

1. discuss the characteristics of water

2. draw the structure of water

3. discuss the structure of water

Previous Knowledge The students are familiar with liquid substances

Introduction of the topic for presentation

The topic will be introduced by displaying the chart of water structure and displaying bowls at various groups for students . Water is defined as a colorless, odorless and tasteless substance

Presentation The teacher set up the structure of water chart and water in a bowl at each group for discussion

Students grouping In carrying out discussion activities, the entire students will be paired up in groups to discuss and share ideas and opinions, and finally, conclusions will be drawn, each group will appoint a leader, secretary and time keeper.

Rules governing each group

Members within the groups should:

i. maintain orderliness by taking turn in the discussion.

ii. respect opinion of every group member for peaceful coexistence.

iii. listen carefully and make contributions.

Various group tasks

All the groups will be assigned the same tasks to discuss the definition of water, draw and the structure of water. The students will be assigned to discuss and share their ideas on the introduced topic by the teacher. They are expected to be discussing, jotting down points and by the end, each group reconciled the points for final presentation to be done to the entire class

Q1: With relevant examples, students will be asked to define water

Q2: How can you explain the structure of water?

Q3: What is the symbol to represent the structure of water?

Teacher's role in the discussion

The teacher will move from one group to the other, listen the trend of what is being discussedin each of the groups. Teacher gives suggestions and encourages them to work as a team for thesuccess of the group because the success of every group depends on the individuals' cooperationand participation. The teacher also has the duty of informing the groups on the time to end theactivity and when to compile their summary of points for presentation.

Culminating Activities

1. The teacher/researcher coordinate and encourage the various groups to : write, organize, compile and present their report to the entire class regarding the areas assigned to them via the group secretary or chairman.

Evaluation Activities

This is a time when the teacher calls for the class members to deliberate on the various reports. Each group will present its report on the task assigned to them through the secretary and the chairman to the entire class. The teacher will listen and assess the extent of their presentation. Final report serves as the reference point for the members of the class. Finally, the teacher encourages students to share all that they have discussed in their various groups by asking them the following questions

1. Discuss the characteristics of water

2. Draw the structure of water.

3. Discuss the structure of water

Conclusion: Students were asked to draw the structure of water

WEEK TWO LESSON PLAN FOR EXPERIMENTAL GROUP II

(DISCUSSION METHOD)

School-	G.S.S Tudun Jukun
Date-	Mon 7th Oct, 2019
Class-	SSI
Average age of students-	15 years
Period-	3rd
Duration-	40mins
Subject-	Chemistry
Topic-	Chemistry and Environment
Sub-topic-	Types, sources and uses of water

Instructional materials- Diagrames on cardboard paper, washing soda, samples of water from borehole and well, pieces of cloths

Behavioural objectives- By the end of the discussion activities, students should be able to:

1. list the types of water

2. mention the sources of water

3. explain the uses of water

Previous Knowledge The students have been taught the concept of water

Introduction The teacher introduces the lesson by asking the students' questions based on their previous knowledge e.g Define water

Presentation The teacher presents the lesson in the following steps:

The teacher set up the topic for discussion: The topic for discussion will be introduced by the teacher with the aid of the diagrams on the cardboard paper.The teacher will display all the instructional materials which include: Diagrams on cardboard paper, washing soda, samples of water from borehole and well, pieces of cloths. There are different types, sources and uses of water. Water could be hard or soft, temporal hardness and permanent hardness.

Students grouping The entire students will be grouped into a convenient group. Members will be made to participate through listening, discussing, explaining, identifying and presenting common views before the class. Each group will appoint a leader, secretary and time keeper among its members.

Rules for students to follow

Students within the groups should:

i. discuss and share their ideas

ii. respect opinion of every group member for peaceful coexistence.

iii. maintain orderliness while discussing.

Various group tasks

All the groups will be assigned the same task to discuss and share their ideas on the introduced

topic of the types, sources and uses of water. The students will be engaged in discussing, jotting points and by the end, each group will reconcile the points for final presentation to be done to the entire class members through group representatives.

Teacher's role in the discussion

The teacher will move from one group to the other, listens to the trend of what are being discusesin each of the groups. He gives suggestions and encourages them to work as a team for thesuccess of the group because the success of every group depends on the individuals' cooperationand participation. The teacher also has the duty of informing the groups on the time to end thediscussion and when to compile their summary of points for presentation.

Culminating Activities

1. The teacher/researcher coordinate and encourage the various groups to : write, organize, compile and present their report to the entire class regarding the areas assigned to them via the group secretary or chairman.

2. The teacher guides students as they return to their seats after the presentation.

Evaluation Activities: This is a time when the teacher calls for the class members to deliberate on the various reports. Each group will present its report on the task assigned to them through the secretary and the chairman to the entire class. The teacher will listen and assess the extent of their presentation. Final report serves as the reference point for the members of the class.

Finally, the teacher encourages students to share all that they have discussed in their various groups by asking them the following questions:

1. list the types of water

2. mention the sources of water

3. discuss the uses of water

Conclusion: Students were asked to list and explain the properties of water

WEEK THREE LESSON PLAN FOR EXPERIMENTAL GROUP II

(DISCUSSION METHOD)

School-	G.S.S Tudun Jukun
Date-	Mon 14th Oct, 2019
Class-	SSII
Average age of students-	15 years
Period-	3rd
Duration-	40mins
Subject-	Chemistry
Topic-	Chemistry and Envitonment
Sub-topic-	Solubility of substances
Instructional materials-	Salt, sugar, sand and water
Behavioural objectives-	By the end of the discussion activities, students should be able to: 1. Define solubility 2. State the rules of solubility in water 3. discuss using salt, sugar and water to determine the solubility of a substance.
Previous Knowledge	Students are familiar with sand, salt, water
Introduction	The teacher introduces the lesson by asking the students questions based on their previous knowledge
Presentation	The teacher presents the lesson in the following steps:

The teacher set up the materials for discussion by displaying the salt , sugar and water.He start the discussion with the students and allow the to continue and share ideas

Students grouping

The entire students are paired up into a small group to discuss and share their ideas after which each group will appoint a leader, secretary and time keeper among its members.

Rules for students to follow

Students within the groups should:

i. understand the need to discuss and share their ideas

ii. respect opinion of every group member for peaceful coexistence.

iii. appreciate the significance of punctuality and constant attendance in school.

Various group tasks

All the groups will be assigned the same task to discuss and share their ideas on the introduced topic. The students will be engaged mainly in discussing, jotting down points and by the end, each group will reconcile the points for final presentation to be done to the entire class members through group representatives.

Teacher's role in the discussion

The teacher will move from one group to the other, listens to the trend of what is being discussed in each of the groups. He gives suggestions and encourages them to work as a team for the success of the group because the success of every group depends on the individuals' cooperationand participation. The teacher also has the duty of informing the groups on the time to end thediscussion and when to compile their summary of points for presentation.

Culminating Activities

1. The teacher/researcher coordinate and encourage the various groups to : write, organize, compile and present their report to the entire class regarding the areas assigned to them via the group secretary or chairman.

2. The teacher guides students as they return to their seats after the presentation.

Evaluation Activities

This is a time when the teacher calls for the class members to deliberate on the various reports. Each group will present its report on the task assigned to them through the secretary and the chairman to the entire class. The teacher will listen and assess the extent of their presentation. Final report serves as the reference point for the members of the class. Finally, the teacher encourages students to share all that they have discussed in their various groups by asking them the following questions:

1. Define solubility

2. State the rules of solubility in water

3. discuss using salt, sugar and water to determine the solubility of a substance

Conclusion: Students were asked to draw a table and classify 5 different items of their choices each into soluble and insoluble substances

WEEK FOUR LESSON PLAN FOR EXPERIMENTAL GROUP II

(DISCUSSION METHOD)

School-	G.S.S Tudun Jukun
Date-	Mon 21st Oct, 2019
Class-	SSII
Average age of students-	15 years
Period-	3rd
Duration-	40mins
Subject-	Chemistry
Topic-	Chemistry and Environment
Sub-Topic	Solubility (Solute, solvent and solution)
Instructional materials-	Sodium chloride, water, gasoline, oil stained pieces of cloth
Behavioural objectives-	By the end of the laboratory activities, students should be able to: 1. Differentiate between solute, solvent and solution 2. Discuss the application of solubility in stain removal
Previous Knowledge	The students have been taught solubility of substances
Introduction	The teacher introduces the lesson by asking the students questions based on their previous lesson
Presentation	The teacher presents the lesson in the following steps:PresentationThe teacher presents the lesson in the following steps:The teacher set up the materials for discussion by displaying the salt , sugar and water.He start the discussion with the students and allow the to continue and share ideas

Students grouping

The entire students are paired up into a small group to discuss and share their ideas after which each group will appoint a leader, secretary and time keeper among its members.

Rules for students to follow

Students within the groups should:

i. understand the need to discuss and share their ideas

ii. respect opinion of every group member for peaceful coexistence.

iii. appreciate the significance of punctuality and constant attendance in school.

Various group task

All the groups will be assigned the same task to discuss and share their ideas on the introduced topic. The students will be engaged mainly in discussing, jotting down points and by the end, each group will reconcile the points for final presentation to be done to the entire class membersthrough group representatives.

Teacher's role in the discussion

The teacher will move from one group to the other, listens to the trend of what is being discussed in each of the groups. He gives suggestions and encourage them to work as a team for thesuccess of the group because the success of every group depends on the individuals cooperationand participation. The teacher also has the duty of informing the groups on the time to end thediscussion and when to compile their summary of points for presentation.

Culminating Activities

1. The teacher/researcher coordinate and encourage the various groups to: write, organize, compile and present their report to the entire class regarding the areas assigned to them via the group secretary or chairman.

2. The teacher guides students as they return to their seats after the presentation.

Evaluation Activities

This is a time when the teacher calls for the class members to deliberate on the various reports. Each group will present its report on the task assigned to them through the secretary and the chairman to the entire class. The teacher will listen and assess the extent of their presentation. Final report serves as the reference point for the members of the class. Finally, the teacher encourages students to share all that they have discussed in their various groups by asking them the following questions:

1. diffrentiate between solute, solvent and solution

2. discuss on the application of solubility in stain removal

Conclusion: Students were asked to find out other solvents for stain removal

WEEK FIVE LESSON PLAN FOR EXPERIMENTAL GROUP II

(DISCUSSION METHOD)

School-	G.S.S Tudun Jukun
Date-	Mon 28th Oct, 2019
Class-	SSII
Average age of students-	15 years
Period-	3rd
Duration-	40mins
Subject-	Chemistry
Topic-	Chemistry and Environment
Sub-Topic-	Factors affecting solubility and uses of solubility curves
Instructional materials-	Source of heat, sugar, salt, water and Petri-dish
Behavioural objectives-	By the end of the discussion activities, students should be able to:
	1. List the factors that affect solubility
	2. Explain how the factors affect solubility
	3. Itemize the uses of solubility curves
Introduction	The teacher introduces the lesson by asking the students questions based on the previous lesson
Presentation	The teacher presents the lesson in the following steps:

Introduction of the topic for discussion by the teacher

Factors that can affect solubility are temperature and pressure. Solubility of solid may increase or decrease with increasing temperature and solubility of gas decreases with an increase in temperature and decrease in pressure.The solubility curves are graphical representation of solubility of certain salt over a temperature range.

Students grouping

The entire students are paired up into a small group to discuss and share their ideas on how temperature can affect solubility after which each group will appoint a leader, secretary and time keeper among its members.

Rules for students to follow

Students within the groups should:

i. understand the need to discuss and share their ideas

ii. respect opinion of every group member for peaceful coexistence.

iii. appreciate the significance of punctuality and constant attendance in school.

Various group task

All the groups will be assigned the same task to discuss and share their ideas on the introduced topic. The students will be engaged mainly in discussing, jotting down points and by the end, each group will reconcile the points for final presentation to be done to the entire class membersthrough group representatives.

Teacher's role in the discussion

The teacher will move from one group to the other, listens to the trend of what is being discussed in each of the groups. He gives suggestions and encourages them to work as a team for the success of the group because the success of every group depends on the individual'scooperation and participation. The teacher also has the duty of informing the groups on the time to end thediscussion and when to compile their summary of points for presentation.

Culminating Activities

1. The teacher/researcher coordinate and encourage the various groups to : write, organize, compile and present their report to the entire class regarding the areas assigned to them via the group secretary or chairman.

2. The teacher guides students as they return to their seats after the presentation.

Evaluation Activities

This is a time when the teacher calls for the class members to deliberate on the various reports. Each group will present its report on the task assigned to them through the secretary and the chairman to the entire class. The teacher will listen and assess the extent of their presentation. Final report serves as the reference point for the members of the class. Finally, the teacher

encourages students to share all that they have discussed in their various groups by asking them the following questions:

1. List the factors that affect solubility

2. Explain how the factors affect solubility

3. Itemize the uses of solubility curves

Conclusion: students were asked to find out the relationship between temperature, pressure and solubility.

WEEK SIX LESSON PLAN FOR EXPERIMENTAL GROUP II

(DISCUSSION METHOD)

Name of school-	G.S.S Tudun Jukun
Date-	Mon 4th Nov, 2019
Class-	SSII
Average age of students-	15 years
Period-	3rd
Duration-	40mins
Subject-	Chemistry
Topic-	Hardness and removal of hardness in water
Instructional materials-	Washing soda, water, source of heat

Behavioural objectives- By the end of the discussion activities, students should be able to:

1. list types of hard water

2. discuss the causes of hardness of water

3. discuss on the removal of hardness

Introduction of the topic for discussion by the teacher: The teacher displayed the washing soda at various points and set up the discussion in the application of soda in water and boiling of water to remove hardness. Water hardness could be temporal or permanent, hardness is as a result of the presence of bicarbonate salt, sulphate and chloride salt and can be removed by heating, treatment with soda or lime water.

Students grouping

The entire students are paired up into a small group to discuss and share their ideas after which each group will appoint a leader, secretary and time keeper among its members.

Rules for students to follow

Students within the groups should:

i. understand the need to discuss and share their ideas

ii. respect opinion of every group member for peaceful coexistence.

iii. appreciate the significance of punctuality and constant attendance in school.

Various group tasks

All the groups will be assigned the same task to discuss and share their ideas on the introduced topic. The students will be engaged mainly in discussing, jotting down points and by the end, each group will reconcile the points for final presentation to be done to the entire class members through group representatives.

Teacher's role in the discussion

The teacher will move from one group to the other, listens to the trend of what is being discussedin each of the groups. He gives suggestions and encourages them to work as a team for thesuccess of the group because the success of every group depends on the individuals cooperation and participation. The teacher also has the duty of informing the groups on the time to end thediscussion and when to compile their summary of points for presentation.

Culminating Activities

1. The teacher/researcher coordinate and encourage the various groups to : write, organize, compile and present their report to the entire class regarding the areas assigned to them via the group secretary or chairman.

2. The teacher guides students as they return to their seats after the presentation.

Evaluation Activities

This is a time when the teacher calls for the class members to deliberate on the various reports. Each group will present its report on the task assigned to them through the secretary and the chairman to the entire class. The teacher will listen and assess the extent of their presentation. Final report serves as the reference point for the members of the class. Finally, the teacher encourages students to share all that they have discussed in their various groups by asking them the following questions:

1. list the types of hardness of water

2. explain the causes of hardness of water

3. discuss the methods employed in the removal of hardness.

Assignment

Students will be asked to list two other chemicals that can cause hardness of water.

WEEK SEVEN LESSON PLAN FOR EXPERIMENTAL GROUP II

(DISCUSSION METHOD)

School-	G.S.S Tudun Jukun
Date-	Mon 18th Nov, 2019
Class-	SSII
Average age of students-	15 years
Period-	3rd
Duration-	40mins
Subject-	Chemistry
Topic-	Production of distilled water
Instructional materials-	distillation apparatus and source of heat
Behavioural objectives-	By the end of the discussion, students should be able to: 1. discuss the procedure for purification of water 2. discuss the production of distilled water

Introduction of the topic for discussion by the teacher

Purification is removal of undesirable chemicals, biological contaminants, suspended solids and gases from water. Distilled water is water that has been boiled into vapor and condensed back into liquid in separate container.

Students grouping

The entire students are paired up into a small group to discuss and share their ideas after which each group will appoint a leader, secretary and time keeper among its members.

Rules for students to follow

Students within the groups should:

i. understand the need to discuss and share their ideas

ii. respect opinion of every group member for peaceful coexistence.

iii. appreciate the significance of punctuality and constant attendance in school.

Various group tasks

All the groups will be assigned the same task to discuss and share their ideas on the introduced topic. The students will be engaged mainly in discussing, jotting down points and by the end, each group will reconcile the points for final presentation to be done to the entire class membersthrough group representatives.

Teacher's role in the discussion

The teacher will move from one group to the other, listens to the trend of what is being discussed in each of the groups. He gives suggestions and encourage them to work as a team for

thesuccess of the group because the success of every group depends on the individuals cooperation and participation. The teacher also has the duty of informing the groups on the time to end thediscussion and when to compile their summary of points for presentation.

Culminating Activities

1. The teacher/researcher coordinate and encourage the various groups to : write, organize, compile and present their report to the entire class regarding the areas assigned to them via the group secretary or chairman.
2. The teacher guides students as they return to their seats after the presentation.

Evaluation Activities

This is a time when the teacher calls for the class members to deliberate on the various reports. Each group will present its report on the task assigned to them through the secretary and the chairman to the entire class. The teacher will listen and assess the extent of their presentation. Final report serves as the reference point for the members of the class. Finally, the teacher encourages students to share all that they have discussed in their various groups by asking them the following questions:

1. discuss the procedure for purification of water
2. discuss the production of distilled water

Conclusion: Students will be asked to explain the process of obtaining distilled water in water works

APPENDIX F

LESSON PLANS FOR CONTROL GROUP (CONVENTIONAL METHOD)

The conventional method is a one way communication line where the teacher give the oral/verbal presentation of facts or he/she does the talking while the learners listens. The students remain passive participants who do not contribute in the lesson in progress. The conventional method is teacher –centered as he dominates the activity of the lesson and gives little or no time for asking and answering questions by the learners.

WEEK ONE LESSON PLAN FOR CONTROL GROUP (CONVENTIONAL METHOD)

School-	G.G.S.S Dogon Bauchi/G.S.S Dakace
Date-	Thurs 26th Sep, 2019
Class-	SSII
Average age of students-	15 years
Period-	2nd&5th
Duration-	40mins
Subject-	Chemistry
Topic-	Chemistry and Environment
Sub-topic-	water
Behavioural objectives-	By the end of the lesson, students should be able to:
	1. define water
	2. draw the structure of water
	3. explain the structure of water
Previous knowledge	The students are familiar with liquid substances
Introduction	lesson will be introduced by asking students questions based on their previous knowledge e.g what is a liguid substance?
Presentation	The teacher will present the lesson through the following steps:
Step1	Water is a substance that is colorless and odorless.
Step II	The teacher displayed the water structure chart on the board. Thestructure of water is rich in oxygen and bounded by two hydrogen molecules.
Step III	The structure of water varies considerably depending on itsphysical State. It is rich in oxygen and bounded by two hydrogenmolecules.
Evaluation	The students were asked the following questions
	1. define water
	2. draw the structure of water
	3. explain the structure of water
Conclusion	teacher made content clarification for better understanding by summarizing points and allow students copy

WEEK TWO LESSON PLAN FOR CONTROL GROUP I

(CONVENTIONAL METHOD)

School-	G.G.S.S Dogon Bauchi/G.S.S Dakace
Date-	Thurs 3rdOct, 2019
Class-	SSII
Average age of students-	15 years
Period-	2nd&5th
Duration-	40mins
Subject-	Chemistry
Topic-	Water
Sub-topic-	Types, sources and uses of water
Instructional material-	Diagrames on cardboard paper, washing soda, samples of water from borehole and well, pieces of cloths
Behavioural objectives-	By the end of the lesson, students should be able to:
	1. list the types of water
	2. mention the sources of water
	3. explain the uses of water
Previous knowledge	students have been taught the concept of water
Introduction	lesson will be introduced by the teacher asking the students questions based on their previous knowledge e.g define water
presentation	lesson will be presented through the following steps
step I	The teacher list the types of water:
	There are basically two types of water, they are: soft water and hard water. Hard water is often unfit for drinking because it contains an element of bicarbonate salt while soft water is without odour, colour or taste.
Step II	The teacher list the sources of water by displaying the diagrams on the cardboard paper for the learners observation: Water is obtained from tap, well, stream, rain and can be with or without odour and with or without colour.
Step III	The teacher list the uses of water: for drinking, washing, water works etc
Evaluation	Students will be asked the following questions
	1. list the types of water
	2. mention the sources of water

	3. explain the uses of water
conclusion	Teacher made content clarification for better understanding by summarizing points and allow students copy the notes

WEEK THREE LESSON PLAN FOR CONTROL (CONVENTIONAL METHOD)

School-	G.G.S.S Dogon Bauchi/G.S.S Dakace
Date-	Thurs 10th Oct, 2019
Class-	SSII
Average age of students-	15 years
Period-	2nd&5th
Duration-	45mins
Subject-	Chemistry
Topic-	Chemistry and Environment
Sub-Topic	Solubility of substances
Instructional materials-	Salt, sugar, sand and water
Behavioural objectives-	By the end of the end of the lesson, students should be able to:
	1. define solubility
	2. State the rules of solubility in water
	3. explain by using salt, sugar and water to determine the solubility of a substance.
Previous Knowledge	Students have been taught the types, sources and uses of water
Introduction	The teacher introduces the lesson by asking the students questions based on their previous knowledge e.g list the types of water
Presentation	The teacher presents the lesson in the following steps:
Step 1	Solubility is the ability to dissolve a substance especiall in a liquid. As the temperature increases, the solubility of the gas generally decreases.
Step 2	The rules of solubility can be Stated as follows:

Solubility Rules

The following are the solubility rules for common ionic solids. If two rules appear to contradict each other, the preceding rule takes precedence.

1. Salts containing Group I elements (Li^+, Na^+, K^+, Cs^+, Rb^+) are soluble . There are few exceptions to this rule. Salts containing the ammonium ion (NH_4^+) are also soluble.
2. Salts containing nitrate ion (NO_3^-) are generally soluble.
3. Salts containing Cl^-, Br^-, or I^- are generally soluble. Important exceptions to this rule are halie salts of Ag^+, Pb^{2+}, and $(Hg_2)^{2+}$. Thus, AgCl, $PbBr_2$, and Hg_2Cl_2 are insoluble.
4. Most silver salts are insoluble. $AgNO_3$ and $Ag(C_2H_3O_2)$ are common soluble salts of silver; virtually all others are insoluble.

5. Most sulfate salts are soluble. Important exceptions to this rule include $CaSO_4$, $BaSO_4$, $PbSO_4$, Ag_2SO_4 and $SrSO_4$.
6. Most hydroxide salts are only slightly soluble. Hydroxide salts of Group I elements are soluble. Hydroxide salts of Group II elements (Ca, Sr, and Ba) are slightly soluble. Hydroxide salts of transition metals and Al^{3+} are insoluble. Thus, $Fe(OH)_3$, $Al(OH)_3$, $Co(OH)_2$ are not soluble.
7. Most sulfides of transition metals are highly insoluble, including CdS, FeS, ZnS, and Ag_2S. Arsenic, antimony, bismuth, and lead sulfides are also insoluble.
8. Carbonates are frequently insoluble. Group II carbonates ($CaCO_3$, $SrCO_3$, and $BaCO_3$) are insoluble, as are $FeCO_3$ and $PbCO_3$.
9. Chromates are frequently insoluble. Examples include $PbCrO_4$ and $BaCrO_4$.
10. Phosphates such as $Ca_3(PO_4)_2$ and Ag_3PO_4 are frequently insoluble.
11. Fluorides such as BaF_2, MgF_2, and PbF_2 are frequently insoluble.

Step 3 Using salt, sugar and water, the teacher explains their solubility: Salt, sugar and water will be displayed by the teacher, the teacher will measure a table spoon of salt a sugar respectively and separately dilute in 50mls of water and allow the students to observe. The solid that dissolve faster with limited time is soluble than the other solid and solubility increases with increase in temperature.

Evaluation Students will be evaluated by asking them the following questions:

1. Define solubility
2. State the rules of solubility in water
3. Explain using salt, sugar and water to determine the solubility of a substance.

Conclusion Teacher made content clarification for better understanding by summarizing points and allow students copy the notes

WEEK FOUR LESSON PLAN FOR CONTROL GROUP (CONVENTIONAL METHOD)

School-	G.G.S.S Dogon Bauchi/G.S.S Dakace
Date-	Thurs 17th Oct, 2019
Class-	SSII
Average age of students-	15 years
Period-	2^{nd}&5^{th}
Duration-	40mins
Subject-	Chemistry
Topic-	Chemistry and Environment
Sub-topic-	Solubility (solvent, solute and solutions)
Behavioural objectives-	By the end of the lesson, students should be able to:
	1. differentiate between solvent, solutes and solution
	2. explain the application of solubility in stain removal
Previous knowledge	students have been taught solubility of a substance
Introduction	lessons was introduced by asking the students questions based
	on their previous knowledge
Presentation	lessons was presented through the following steps
	The teacher differentiates between solute, solvent and solutions
Step I	A liquid that dissolve something is called a solvent. Mixtures of two or more substances are a solution. The dissolved substance is called the solute.
	The teacher explains the application of solubility in stain removal
Step II	In applying solubility to remove stains, sodium chloride, water gasoline and a pieces of cloth stained with oil can be used.**A** quantity of sodium chloride (NaCl) and dissolve in a given quantity of water (H2O)
Step III	The teacher writes the chemical equation of sodium chloride + water: NaCl+H2O=NaOH+Hcl
Step 5	The teacher poured out a quantity of gasoline on the oil stained pieces of cloth and allow the students to observe. For example, water is a good solvent for dissolving salt and sugar, however, it is not a good solvent for dissolving oil or butter. Stain removers often contain alcohol which acts as a solvent for both water-based

	and oil based stains.Hydrocarbon solvents, such as gasoline, may be used to dissolve some stains.
Evaluation	students were asked the following questions 1. What is the difference between solvent, solutes and solution? 2. Explain the application of solubility in stain removal
Conclusion	Teacher made content clarification for better understanding by summarizing points and allow students copy

WEEK FIVE LESSON PLAN FOR CONTROL GROUP (CONVENTIONAL METHOD)

School-	G.G.S.S Dogon Bauchi/G.S.S Dakace
Date-	Thurs 24th Oct, 2019
Class-	SSII
Average age of students-	15 years
Period-	2nd&5th
Duration-	40mins
Subject-	Chemistry
Topic-	Chemistry and Environment
Sub-Topic-	Factors affecting solubility
Instructional materials-	Sources of heat , sugar, salt, water
Behavioural objectives-	By the end of the lesson, students should be able to: 1. list the factors that affect solubility 2. explain how the factors affects solubility
Previous knowledge	students have been taught solvent, solute and solutions
Introduction	lesson was introduced by asking students questions based on their previous knowledge.
presentation	lesson was presented through the following steps
Step I	The teacher lists the factors that affects solubility Factors that can affect solubility are temperature and pressure.
Step II	The teacher explained how these factors affects solubility: Solubility of solid may increase or decrease with increasing temperature and solubility of gas decreases with an increase in temperature and decrease in pressure. Solubility of solid may increase or decrease with increasing temperature and solubility of gas decreases with an increase in temperature and decrease in pressure. The teacher explains to the students how to dissolve some quantity of salt in water at room temperature and also put

some quantity of salt in water using a petric dish and apply heat then observe which one becomes soluble faster.

Factors That Affect Solubility: Certain factors can change the solubility of a solute. Temperature is one such factor. How temperature affects solubility depends on the State of the solute

Evaluation students were asked the following questions

1. list the factors that affect solubility

2. explain how the factors affects solubility

Conclusion Teacher made content clarification for better understanding by summarizing points and allow students copy

WEEK SIX LESSON PLAN FOR CONTROL GROUP (CONVENTIONAL METHOD)

School-	G.G.S.S Dogon Bauchi/G.S.S Dakace
Date-	Thurs 31st Oct, 2019
Class-	SSII
Average age of students-	15 years
Period-	2nd&5th
Duration-	40mins
Subject-	Chemistry
Topic-	Chemistry and Environment
Sub-topic-	Hardness and removal of hardness in water
Behavioural objectives-	By the end of the lesson, students should be able to:
	1. list the types of hard water
	2. explain the causes of hard water
	3. explain the procedure of removal of hardness of water
Previous knowledge	Students make use of water
Introduction	Lesson was introduced by asking students questions based on their previous knowledge
Presentation	Lesson was presented through the following steps
Step1	The teacher listed the types of hard water
	Water hardness could be temporal or permanent.
Step II	Hardness is as a result of the presences of bicarbonate salt, sulphate and chloride salt.
Step III	The teacher explains the procedure for removal of hardness of
	Water: Water hardness can be removed by heating, treatment with soda or limewater, etc
Evaluation	Students were asked the following question
	1. list the types of hard water 2. expain the causes of hard water 3. explain the procedure of removal of hardness of water
Conclusion	Teacher made content clarification for better understanding by
	summarizing points and allow students copy

WEEK SEVEN LESSON PLAN FOR CONTROL GROUP

(CONVENTIONAL METHOD)

Name of school-	G.G.S.S Dogon Bauchi/G.S.S Dakace
Date-	Thurs 7th Nov, 2019
Class-	SSII
Average age of students-	15 years
Period-	2nd &5th
Duration-	40mins
Subject-	Chemistry
Topic-	Chemistry and Environment
Sub-topic-	Production of distilled water
Instructional materials-	distillation apparatus and source of heat
Behavioural objectives-	By the end of the lesson, students should be able to: 1. explain the procedure for purification of water 2. explains the production of distilled water
Previous knowledge	The students have been taught hardness in water
Introduction	lesson was be introduced by asking students questions based on their previous knowledge
Presentation	lesson was presented through the following steps:
Step 1	The teacher explains purification of water as the removal of undesirable chemicals, biological contaminants, suspended solids and gases from water. Distilled water is water that has been boiled into vapor and condensed back into liquid in separate container.
Step 3	The teacher placed the diagram of a distillation apparatus on the board for the students observation and explained the procedure for obtaing distilled water
Evaluation	students were asked the following questions 1. explain the procedure for purification of water 2. explains the production of distilled water
Conclusion	teacher made content clarification for better understanding by

summarizing points and allow students copy

APPENDIX G

CHEMISTRY STUDENTS PERFORMANCE AND RETENTION TEST (CSPART) MARKING SCHEME

(1) C
(2) D
(3) B
(4) A
(5) D
(6) C
(7) A
(8) B
(9) D
(10) C
(11) D
(12) A
(13) D
(14) C
(15) C
(16) D
(17) D
(18) C
(19) C
(20) C
(21) D
(22) D
(23) B
(24) D
(25) B
(26) D
(27) B
(28) D
(29) C
(30) C
(31) D
(32) A
(33) C
(34) A
(35) C
(36) A
(37) C
(38) C
(39) D
(40) B
(41) A
(42) D
(43) A
(44) C
(45) C
(46) D
(47) A
(48) C
(49) B
(50) B

APPENDIX H

TRAINING MANUAL FOR RESEARCH ASSISTANTS (TMRAS)

This research work is on two teaching methods namely laboratory and discussion methods used in teaching Chemistry to SSII students in Kaduna State. The researcher selected two (2) research assistants and trained them on the teaching methods employed in the study. A research assistant is temporary a researcher employed often on a temporary contract for the purpose of assisting in academic research. Research assistants are not independent and not directly responsible for the outcome of the research work. They are experienced Chemistry teachers who are university graduates teaching in selected schools under study.

PROCEDURE FOR THE RESEARCH WORK

.The researcher met with the Chemistry teachers of the selected schools for the study.

. The researcher then selected the research assistant after a brief introduction of themselves, and then a subsequent short interview followed.

. The aim of the interview was to select Chemistry teachers based on competence as research assistants.

. After the selection, the researcher provided an overview of the research at the beginning of the session, detailing what is expected of them from the research, the timeframe, regular meetings with the students during lesson periods.

. The researcher explained from the onset, useof lesson plans, administering of test items from the beginning of the study to the end

The researcher also explained to the two (2) research assistants that the data for the study is to be collected through the administration of pre-test, post-test and retention

test of fifty (50) multiple choice objectives test items. The data collection phase lasted for ten weeks. Before the treatment, students in both experimental and control groups were exposed to a pre-test.

1. The researcher and the research assistants administered a pre-test to the students in all the groups using an instrument tagged Chemistry student performance and retention test (CSPRT) before the commencement of the treatment.

2. The researcher with the help of the assistants taught the students as outlined in the lesson plans for a period of eight weeks.

3. The researcher taught the experimental groups using laboratory and discussion teaching methods while the control groups were taught with conventional method by both the researcher and the research assistant who were experienced Chemistry teachers with required teaching qualification at the Senior secondary level of a minimum of eight (8) years exposure to Senior secondary level Chemistry curriculum.

4. After the treatment, a post test was administered to both the experimental and control groups by the researcher with the help of the research assistants.

5. Retention test was also administered by the researcher and the research assistant to all groups (experimental and control) after two weeks of post test administration. This was to determine the students' retention ability.

6. The scripts were collected, marked scored and recorded to make comparison between the groups with the help of the research assistants.

7. The three groups were taught using the same content selected from SS II curriculum under the same condition in their different schools.

8. After the treatment, the students in the experimental and control groups were exposed to post-test in order to determine their performance.

9. The researcher was regularly meeting with the research assistants.

DEPARTMENT OF EDUCATIONAL FOUNDATIONS & CURRICULUM
FACULTY OF EDUCATION
AHMADU BELLO UNIVERSITY, ZARIA

Instrument Validation Form

Dear Sir/Ma,

The candidate is a postgraduate student of Educational Foundations and Curriculum Department, Ahmadu Bello, Zaria. He/she is hereby humbly requesting your assistance in validating this research instrument. Please, grant the candidate all the necessary assistance. Thank you.

.....

Head of Department (Signature, Date & Official Stamp

Student's Surname: ADEJO ..... **Other Name:** ONOKA, LUC

Registration Number: P16 SOFE 8026 ..... **Programme:** PhD CURRICULUM S

Title of the Instrument: CHEMISTRY STUDENTS PERFORMANCE A RETENTION TEST

Please comment on the following:

1. Appropriateness of the instrument for the research work: The instrument is appropriate
2. Clarity and simplicity of the language used: clear and simple language
3. Suitability of the instrument for the level of respondents: OK
4. The extent in which the items cover the topic it meant to cover: Covers the topic "Water"
5. Is the instrument properly structured in line with objectives and research questions? Yes
6. Others (grammatical errors, spelling errors and others) Corrected

7. General comment on the instrument: It is applicable for its purpose

Suggestion(s) for improving the quality of the instrument

1. Use the word Except in place of Incorrect in the identified areas
2. Include the abbreviation for Chemistry Students performance and Retention Test i.e CSPART in bracket
3.
4.

ATTESTATION SECTION

I hereby testify that the above named student brought his/her instrument for validation

Name of Attester: M.O. Ibrahim

Designation: Reader

Name and Address of Institution: Dept. of Science Educ A.B.U Zar

Phone No: 08060431619 **E-mail:** Marolaib@gmail.com

24/09/2019

Signature and Date

Thank You

DEPARTMENT OF EDUCATIONAL FOUNDATIONS & CURRICULUM
FACULTY OF EDUCATION
AHMADU BELLO UNIVERSITY, ZARIA

Instrument Validation Form

Dear Sir/Ma,

The candidate is a postgraduate student of Educational Foundations and Curriculum Department, Ahmadu Bello, Zaria. He/she is hereby humbly requesting your assistance in validating this research instrument. Please, grant the candidate all the necessary assistance. Thank you.

.....

Head of Department (Signature, Date & Official Stamp

Student's Surname..ADESOJI..... **Other Name**..OMOKA LUCY.....

Registration Number: ..[illegible]SF0[illegible]..... **Programme:** PhD CURRICULUM & IN

Title of the Instrument: CHEMISTRY STUDENTS PERFORMANCE AND RE

Please comment on the following:

1. Appropriateness of the instrument for the research work: ..Appropriate except for little typographical errors.....
2. Clarity and simplicity of the language used..Very clear.....
3. Suitability of the instrument for the level of respondents: ..Suitable.....
4. The extent in which the items cover the topic it meant to cover:..It Covers the relevant areas.....
5. Is the instrument properly structured in line with objectives and research questions? ..... Yes .....
6. Others (grammatical errors, spelling errors and others)..has been Corrected.....

7. General comment on the instrument: The instrument is O.K but the Corrections should be effected

Suggestion(s) for improving the quality of the instrument

1. The spacing should be double line.
2. The options should be arranged Vertically for clearity
3. Some peculiar statements should be bold or Underlined
4. The statement should be in a very simple English

ATTESTATION SECTION

I hereby testify that the above named student brought his/her instrument for validation

Name of Attester: Dr Binta A. Muhammad

Designation: Chief Lecturer

Name and Address of Institution: Federal College of Education

Phone No: 07063315388 **E-mail:** amrabintafce@gma

09/09/2019

Signature and Date

Thank You

DEPARTMENT OF EDUCATIONAL FOUNDATIONS & CURRICULUM
FACULTY OF EDUCATION
AHMADU BELLO UNIVERSITY, ZARIA

Instrument Validation Form

Dear Sir/Ma,

The candidate is a postgraduate student of Educational Foundations and Curriculum Department, Ahmadu Bello, Zaria. He/she is hereby humbly requesting your assistance in validating this research instrument. Please, grant the candidate all the necessary assistance. Thank you.

Head of Department (Signature, Date & Official Stamp

Student's Surname: ABETO Other name: LUCY OMOK

Registration Number: PG/PHD/17/8 Programme: PhD CURRIC INST.

Title of the Instrument: CHEMISTRY ABORATION & DISCUSSION RE TION AND PERFORMANCE TEST.

Please comment on the following:

1. Appropriateness of the instrument for the research work: Relevant

2. Clarity and simplicity of the language used: OK

3. Suitability of the instrument for the level of respondent: Appropriate

4. The extent in which the items cover the topic it meant to cover: Very effective

5. Is the instrument properly structured in line with objectives and research questions? Yes

6. Others (grammatical errors, spelling errors and others): NIL

7. General comment on the instrument: Infact the instrum Is Relevant & efficient

Suggestion(s) for improving the quality of the instrument

1. Create spacing between each question.
2. .....
3. .....
4. .....

ATTESTATION SECTION

I hereby testify that the above named student brought his/her instrument for validation

Name of Attester: Dr. Lawal Garba Ali

Designation: Chief Lecturer

Name and Address of Institution: Federal College of Education, Zaria

Phone No: 07038883964 E-mail: lawalgani630@gmail.c

Dr. 23/09/19

Signature and Date

Thank You

DEPARTMENT OF EDUCATIONAL FOUNDATIONS AND CURRICULU
Faculty of Education
AHMADU BELLO UNIVERSITY, ZARIA

Vice-Chancellor: Professor Ibrahim Garba, *B.Sc (Hons) Geology, M.Sc (Mineral Exploration) ABU, Ph.D Geology (London), D.I.C., FH.*
Head of Department: Dr. Musa Idris Harbau, *GRII (TC), NCE, B.A.(Ed), M.Ed Admin and Planning (BUK), PhD Admin and Planning (ABU)*

Our Ref. DEFC/S.25

Date: 17/9/18

The Director,
Ministry of Education,
Quality Assurance Authority (QAA)
Division, Zaria.

Dear Sir,

LETTER OF INTRODUCTION

The bearer, ADEJO, Onoka Lucy with Registration Number P16EDFC9026 is a student in this department. He /She is carrying out research, being part of requirement for graduation, in PhD Curriculum & Instruction. He/She needs certain information in your organization. Kindly, allow him/her have access to information in your organization. The information obtained will be used for research purpose only. The topic of his/her research is

Evaluation of the effects of laboratory and Discus methods on the performance and Retention of Jun Students in Senior Secondary schools Kad State, Nigeria

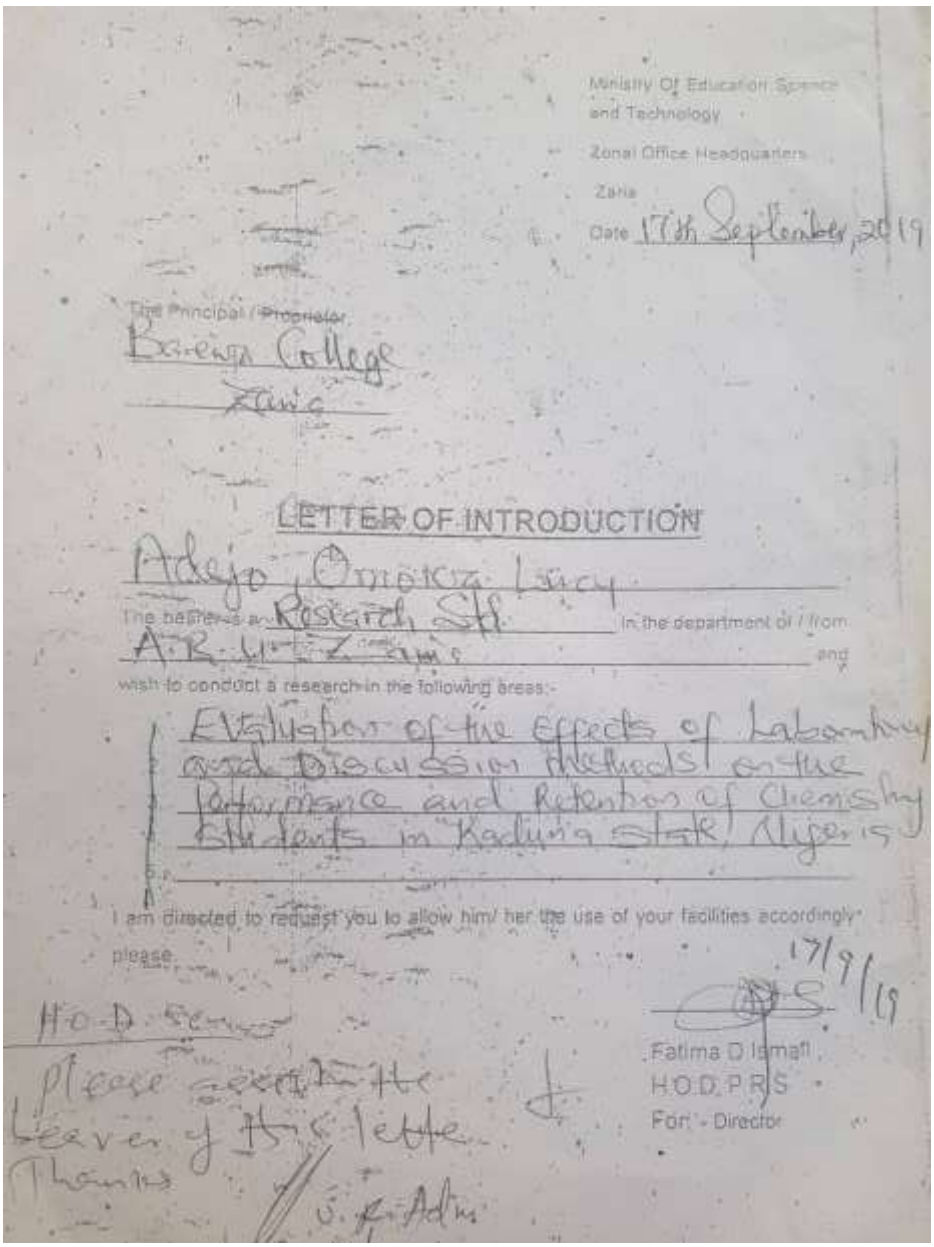
Thanks in anticipation of your kind response.

Yours sincerely,

17/9/2018

Dr. M.I. Harbau
Head of Department

Head of Department
Dept. of Educational Foundations & Curriculum
A.B.U. Zaria



Ministry Of Education Science and Technology

Zonal Office Headquarters

Zaria

Date 17th September, 2019

The Principal / ~~Proprietor~~

Barewa College

Zaria

LETTER OF INTRODUCTION

Adejo Omoiza Lucy

The bearer is a Research Stf. in the department of / from

A.B.U. Zaria and

wish to conduct a research in the following areas:-

Evaluation of the Effects of Laboratory and Discussion Methods on the Performance and Retention of Chemistry Students in Kaduna State, Nigeria

I am directed to request you to allow him/ her the use of your facilities accordingly please.

17/9/19

Fatima D Ismail

H.O.D. P.R.S

For: - Director

H.O.D. Sc.

Please accept the bearer of this letter.

Thanks

S. K. Adm

Ministry Of Education Science and Technology

Zonal Office Headquarters

Zaria

Date 17th September, 2019

The Principal / Proprietor,

G S S Tudun

Wukari, Zaria

LETTER OF INTRODUCTION

Adejo Omoka Lucy

The bearer is a Research Student in the department of / from

ABU Zaria and

wish to conduct a research in the following areas:-

1. Evaluation of the Effects of Laboratory
2. and Discussion Methods on the
3. Performance and Retention of Chemistry
4. Students in Kaduna State, Nigeria
5.

I am directed to request you to allow him/ her the use of your facilities accordingly please.

17/9/19

Fatima D Ismail
H.O.D. P.R.S
For: - Director

Hod Science,

Pls give every assistance to this researcher to obtain data for her project

18/09/19

and Technology

Zonal Office Headquarters

Zaria

Date 17th September, 2019

The Principal / Proprietor,

G.G.S.S DOGON

BAUCHI SNR. Zaria

LETTER OF INTRODUCTION

Adejo Omoka Lucy

The bearer is a Research Student in the department of / from A.B.U. Zaria and wish to conduct a research in the following areas:-

Evaluation of the effects of Laboratory and Discussion methods on the performance and Retention of Chemistry Students in Kaduna State Nigeria.

I am directed to request you to allow him/ her the use of your facilities accordingly please.

17/9/19

Fatima D Ismail
H.O.D. P.R.S
For: - Director

HOD Science
The bearer needs your attention to meet the Chemistry Teacher concerned.

Vice Principal Admin
GGSS D/Bauchi (Snr)
Zaria
Date 18/09/19

Ministry Of Education Science and Technology

Zonal Office Headquarters

Zaria

Date 17th September, 2019

The Principal / Proprietor,

G.S.S Dakace

Zaria

LETTER OF INTRODUCTION

Adejo Omoka Lucy

The bearer is a Research Student in the department of / from A.B.U Zaria and wish to conduct a research in the following areas:-

1. Evaluation of the effects of Laboratory and
2. Discussion methods on the performance
3. and Retention of Chemistry students
4. in Kaduna State, Nigeria.
5.

I am directed to request you to allow him/ her the use of your facilities accordingly please.

VP Acad

Pls above is a researcher, Lease with HOD Science And See where they Can be put through.

17/9/19

17/9/19

Fatima D Ismail
H.O.D. P.R.S
For: - Director

HOD Sciences
Pls take over and address the bearer accordingly.
VP Acad