EFFECTS OF COOPERATIVE AND LABORATORY METHOD ON PERFORMANCE AND RETENTION OF STUDENTS IN CHEMISTRY IN SECONDARY SCHOOLS IN JIGAWA STATE, NIGERIA

BY

MUKHTAR UMAR

DEPARTMENT OF EDUCATIONAL FOUNDATIONS AND CURRICULUM,
FACULTY OF EDUCATION,
AHMADU BELLO UNIVERSITY,
ZARIA, NIGERIA

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BY

Mukhtar UMAR,
(B.Sc. Ed. Chemistry, ABU, M. Ed. Curriculum, BUK)
P15EDFC9002

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

DEPARTMENT OF EDUCATIONAL FOUNDATIONS AND CURRICULUM,
FACULTY OF EDUCATION,
AHMADU BELLO UNIVERSITY,
ZARIA, NIGERIA

SEPTEMBER, 2018

DECLARATION

I declare that the work in this thesis entitledEffects of cooperative and laboratory method on performance and retention of students in chemistry in secondary schools in Jigawa state, Nigeria has been performed by me in the Department of Educational Foundations and Curriculum, Faculty of Education. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this thesis was previously presented for another degree or diploma at this or any other Institution.

……
……
MUKHTAR UMAR Date

CERTIFICATION

This thesis entitled EFFECTS OF COOPERATIVE AND LABORATORY METHOD ON PERFORMANCE AND RETENTION OF STUDENTS IN CHEMISTRY IN SECONDARY SCHOOLS IN JIGAWA STATE, NIGERIA by Mukhtar UMAR with registration number P15EDFC9002 meets the regulations governing the award of the degree of Doctor of Philosophy in Curriculum and Instruction of the Ahmadu Bello University Zaria, and is approved for its' contribution to knowledge and literacy presentation.

……. Date…….
Dr. A. A. Dada
Chairman, Supervisory Committee

……. Date…….
Dr. (Mrs) H. O. Yusuf
Member, Supervisory Committee

……. Date…….
Prof. R. B. Bako
Member, Supervisory Committee

……. Date…….
Dr. M. I. Harbau
Head of Department

…… Date…….
Prof. A. Z. Abubakar
Dean, School of Postgraduate Studies

DEDICATION

This thesis is dedicated to my late Aunty Hajiya Ramlatu (Hajja Dinde) and her late Husband Alhaji Adamu (Dangwalele).

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ABSTRACT

The study examined the effects of cooperative and laboratory method on performance and retention of students in chemistry in secondary school in Jigawa state, Nigeria. The study was carried out with six objectives, which are to; find out the effect of cooperative learning strategy on 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 method on students' performance in chemistry when compared to conventional lecture method and determine the effect of laboratory method 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. 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 better than those taught the same concept using conventional method of teaching in secondary schools in Jigawa State that is, Significant difference exists between the performance of students taught chemistry concept using laboratory method and those using lecture method in secondary schools in Jigawa State among other findings. Based on the findings of the study, 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' 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 method as a commonly used method 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 guiding teachers and researchers alike on how to use the model in teaching and learning.

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LIST OF ABBREVIATIONS

NISP:	Nigeria Integrated Science Project
STAN:	Science Teachers Association of Nigeria
NSQP:	National Science Quiz Project
NMIP:	National Mathematics Improvement Project
NMC:	National Mathematical Centre
NSSSP:	National Secondary School Science Project
CESAC:	Comparative Education Study and Adaptation Centre
NERDC:	Nigeria Educational Research and Development Council.
SPSS:	Statistical Package for Social Sciences
FME:	Federal Ministry of Education
TRCN:	Teachers Registration Council of Nigeria
EGR:	Expert Group
EG 1:	Experimental Group One
EG 2:	Experimental Group Two
CG:	Control Group
ABPT:	Acid Base Performance Test
CLS:	Cooperative Learning Strategy
CTAC:	Community Training and Assistance Center.
WCSD:	Washoe County School District.
CHAT:	Cultural-Historical Activity Theory
FJCM:	Field-jigsaw Cooperative Model

OPERATIONAL DEFINITION OF TERMS

Performance: refers to the achievement scores obtained by students in Senior Secondary Two (SSII) Chemistry Examinations

Retention: is the ability to store and recalled information easily on chemistry concepts after a minimum period of two weeks.

Instructional Strategy: the process and procedure involved in teaching/learning of concepts

Cooperative Instructional Strategy: refer to the situation where students learn the concepts of chemistry together in small heterogeneous groups and helping each other during teaching and learning process with the support from the teacher.

LaboratoryMethod: refers to learning of chemistry concepts in a functioning laboratory where students interact with apparatus and materials during the teaching and learning process. It is similar to laboratory –based strategy.

Academic Performance: refer to the results obtained from the test administered immediately after treatment given to both experimental and control groups.

Academic Retention Ability: is the ability to recall the concepts of acid and base after the retention test.

Cooperative and Laboratory Method: refers to cooperative learning strategy and laboratory method.

Conventional Method: refers to lecture method or traditional method

CHAPTER ONE
INTRODUCTION

1.1 Background to the Study

Education is the greatest tool for national development and is what makes human beings the greatest specie of all living creatures on earth. Based on this, science and technology play important role toward this human success and it is therefore the keys to development for every individual, community or the nation at large. The basis of every scientific and technological development is education, and the history of teaching science subjects in Jigawa state secondary schools can be traced back to the former Kano state from where Jigawa was created. Learning of science subjects like chemistry, biology and physics at secondary school level served as the foundation which prepare students to take career in science. This is the basis of producing science teachers, medical doctors, engineers, laboratory technologies and so forth who are expected to contribute their quotas towards the development of their society.

However, Jigawa State is regarded as one of the educationally disadvantaged states in Nigeria. It has one of the lowest teacher/pupil ratios and one of the lowest school enrolment figure, compared to its neighbours in the North –west region. According to recent statistics on education parameters/surveys, less than 70% of boys in the state of school age attend schools, while less than 50% of girls of school age attend school (Nagado, 2016). The state also has one of the poorest numbers of classrooms, compared to other states in the North-west with less than 10,000 classrooms in 2015, the ratio of classes versus pupils is so poor that 67 pupils use a class at primary level, with 61 per class at junior secondary school level and 44 students per class at senior secondary school level. By the end of 2015, the number of teachers in senior

secondary schools in the state is so pathetic with the schools having a little more than 2,000 (Nagado, 2016). It appears that only few teachers are committed to the business and mostly use traditional teaching method (lecture method).

In related development, the National Policy on Education (NPE) is the major document which guide and gear the educational activities in Jigawa and Nigeria at large. The National Policy on Education state that science and technology shall continue to be taught in an integrated manner in the schools to promote in the students, the appreciation of practical application of basic ideas (FRN, 2013).To this end, the place of chemistry in the national secondary schools curriculum in preparing students to become future scientist cannot be over emphasized. Chemistry occupies a unique position in the school curriculum, and is central to many science related courses such as Engineering, Mathematics, Physics, Agriculture, Biology, Geography and Pharmacy. In view of this, teachers are always on the go, searching for a better teaching strategies for a successful and effective delivery which will enhance performance and retention among chemistry students.

Furthermore, the policy stressed that individuals (learners) shall be prepared to become useful members to the society and conversant with the realities of the immediate environment and the world at large (FRN, 2013). Related to this, Dada (2012) opined that the dynamic of education requires that every society device ways not only for ensuring the wellbeing of its members but also, for preparing a better future for the upcoming generation with appropriate knowledge, skill and values. Hence the need for teaching science subjects like chemistry in our secondary schools. Chemistry as a subject is been offered in the senior secondary schools of Jigawa state which are under the control and supervision of the state ministry of education. Therefore chemistry, as one of the science subjects in secondary schools,

has an important role to play in achieving the above policy statement. This can be done by supporting students to learn chemistry concepts like air, water, acids and bases and so forth, which they interact with, in their everyday lives.

However, in every teaching and learning situation, there should be a very good interaction between the teacher, learner and the content or the materials to be learned. The above scenario can be guided by a well stated instructional objectives, which Yusuf (2012) opined that instructional methods should be selected based on the instructional objectives expected to achieved. Therefore, for teaching process to occur successfully, there supposed to be an effective teaching method(s). There are several teaching methods/strategies employed by teachers during teaching and learning which depends on the teaching/learning situation. Many scholars have identified several instructional strategies in teaching sciences particularly chemistry. This includes lecture, inquiry, problem solving, demonstration, cooperative strategy, guided discovery, project laboratories, field trip/ excursion and so forth. But many scholars opined that lecture method is predominantly used in our educational institution (Aina, 2009; Sola & Ojo, 2007; & Suleiman, 2010). Based on this premise, it seems that chemistry teachers in Jigawa state use conventional (lecture) method than any other strategies in their teaching. This method is characterized as teacher –centred because it involved the transmission of knowledge to learners characterized as one – way flow of information from the teacher who is always active to the learner who is always passive.

In contrary, the new trend in teaching now is the learner –centred approach which calls for the teacher to play the role of supporting the learning process. In this arrangement, the learner is exposed to the learning situation under the guidance and support of the teacher.Therefore, chemistry teachers need to create an enabling

environment by way of choosing better learning strategies which will pave way to a successful teaching and learning process. It seems that the use of appropriate instructional strategies which favours the learner –centred approach may improve performance. Therefore, this study intends to use cooperative and laboratory method in enhancing performance and retention among secondary school students in Jigawa state.

Moreover, there is consistent reports of students' low performance in science (chemistry inclusive) in Nigeria (Olatoye & Afuwape, 2004). Jigawa state as one of the thirty-six state in Nigeria is not an exception to the above mentioned trend. Looking at secondary school qualifying examination in Jigawa state, the data obtained showed that out of 856 students that sat for the examination in 2013, a total of 339 (39.6%) pass at credit level while 517 (60.4%) fail the exam. Also out of 706 students that sat for the examination in 2014, a total of 379 (53.7%) pass at credit level while 327 (46.3%) fail the examination (appendix G).

Based on the information presented, the study intends to provide some possible solutions through the use of alternative instructional strategies. Also, to find out which of the strategies will be more effective in promoting performance and retention when compared to the traditional (lecture) method among secondary school two (SSII) chemistry students. It is against this background that this study intends to determine the effects of cooperative and laboratory method on performance and retention among chemistry secondary schools students in Jigawa state, Nigeria.

1.2 Statement of the Problem

Chemistry is one of the science subjects offered in senior secondary schools which form the basis of future scientists and technologists. It appears that chemistry is

considered by many of the secondary school students as a difficult subject and majority of the teachers use the traditional lecture method often than the alternative instructional strategies. This may be a reason for students' poor performance in the subject. Ajewole and Ivowi cited in Goje (2014) stressed that over the years, results of studies have shown that students have continue to perform poorly in science, chemistry inclusive. This is due to so many reasons among which include the choice of the instructional strategies, the non –availability of resource materials, parents support towards education of their children, over loaded curriculum, lack of clearly stated framework for instructional strategies, poor classroom management and lack of scientific equipment in the laboratories usually causes poor performance in chemistry (Madugu & Shuaibu in Abdullahi, 2014). This implies that lack of good instructional strategy employed by chemistry teachers may cause low performance in teaching and learning of chemistry in secondary schools.

In related development, the lecture method is also known to cause lack of interest and poor performance in science as opined by Njoku (2007). In the same vein, science teachers are mostly limited to exclusively adopting this method by telling, reciting and testing of information which is regarded sterile as it does not convey either the meaning or intent of science. Akpan in Shehu (2016) specifically stated that lecture method is the method dominating science teaching in Nigerian Secondary Schools. Therefore, the need for a better instructional strategy like cooperative and laboratory method is necessary. Mari, and Okebukola, cited in Abdullahi (2014) have called for a change from lecture method in teaching Chemistry. Cooperative and laboratory method are therefore very important aspect of student -centred learning. Student learn best when they can work together, discuss what they are doing, help each other and learn from each other. At present student

are not being given the opportunity to do this in schools (David, 2010). Therefore, the need for change in paradigm is necessary for better chemistry performance in our schools.

Moreover, it seems that secondary school students perceived science subjects as difficult. To be specific, the teaching and learning of chemistry is widely perceived as a difficult subject because of its specialized language, mathematical and abstract conceptual nature and the amount of content to be learnt. The prevailing teaching practices (the traditional approach) do not actively involve students in the learning process where by making them to be passive listeners. Studies have shown that the use of cooperative and laboratory instructional strategies is a way of improving quality instruction and subsequently improved students' academic performance (Stephen & Donna; Teresa & Gregory, cited in Goje, 2014). Also from the results of chemistry qualifying examinations (see appendix G), it can be noticed that there is poor performance among chemistry students in Jigawa state. To that effect, this study attempts to investigates the effect of cooperative and methodsed instructional strategieson performance and retention among chemistry secondary school students in Jigawa state.

1.3 Objectives of the Study

The main objective of this study is to examine theeffects of cooperative and laboratory method on performance and retention of students in chemistry in secondary school in Jigawa state, Nigeria. The specific objectives of the study are to:

1. find out the effect of cooperative learning strategy on academic performance of students in chemistry when compared to conventional method;
2. ascertain the effect of cooperative learning strategy on students' retention ability in chemistry;

3. investigate the effect of laboratory method on students' academic performance in chemistry when compared to conventional method;
4. determine the effect of laboratory method on students' retention ability in chemistry;
5. compare students' performance taught with cooperative strategy, laboratory method and conventional method; and
6. compare the retention ability of students taught chemistry with cooperative strategy, laboratory method and lecture method.

1.4 Research Questions

The following research questions are set for answers in this study:

1. What is the mean score difference in academic performance of chemistry students taught using cooperative learning strategy and those taught with conventional method?
2. What is the effect of cooperative learning strategy on students' retention ability in chemistry?
3. What is the mean score difference in academic performance of chemistry students taught using laboratory method and those taught with conventional method?
4. What is the effect of laboratory method on students' retention ability in chemistry?
5. What is the difference in performance of students taught chemistry with cooperative, laboratory and conventional methods?
6. What is the difference in retention ability between students taught with cooperative, laboratory and conventional methods?

1.5 Research Hypotheses

To answer the questions raised above, the following null hypotheses were set for testing:

H_{O1}: There is no significant difference in the performance mean score of students taught chemistry using cooperative learning strategy and those taught with the conventional lecture method.

H_{O2}: There is no significant difference in retention ability of students taught chemistry with cooperative learning strategy and those taught with conventional method

H_{O3}: There is no significant difference in the performance mean scores of students taught chemistry using laboratory method and those taught with the conventional lecture method.

H_{O4}:There is no significant difference in retention ability of students taught chemistry with laboratory method and those taught with conventional method.

H_{O5}:There is no significant difference in performance of students taught chemistry with cooperative strategy, laboratory method and conventional method.

H_{O6}:There is no significant difference in retention ability between students taught with cooperative strategy, laboratory method and conventional method.

1.6 Basic Assumptions

The study will be conducted on the following assumptions that:

i. the students in the study sample are being taught chemistry lesson using the traditional lecture method but are not exposed to cooperative instructional strategy.

ii. chemistry students are not exposed to learning strategies/methods that will enhance students' retention ability.

iii. chemistry students are not used to laboratory method because teachers prepare to take their lessons in conventional classrooms even when laboratories are available in the schools.

iv. students are only exposed to practical chemistry lesson when it is time for WAEC/NECO practical examinations

v. the students' performance in secondary school chemistry is nothing to write home about.

vi. Instructional strategies/methods like cooperative and laboratory method enhances students' performance in chemistry.

1.7 Significance of the Study

The study will be of significance to education as a system, educational associations/organization and the education stakeholders. The beneficiaries of this study include; teachers, school authorities, educational planners, Teachers Registration Council (TRCN), Science Teacher Association of Nigeria (STAN), students, researchers, text book authors/writers/publishers, ministry of education at both state and federal level. The study will be of great significance to chemistry teachers in the adaptation of the appropriate instructional strategies in teaching chemistry at secondary school level. It will help the teachers to apply alternative strategies such as cooperative and laboratory –based instructional methods.

The study will guide school authorities in appreciating laboratory as the best learning environment for using laboratory method, and it differs from the conventional classroom setting there by equipping it with materials and apparatus for practical activities. Findings from this study will shed more light on how chemistry lessons should be organized, by identifying the basic roles of the teachers, learners and the curriculum materials to be developed for effective teaching and learning of chemistry in line with learner centered approach.

The study will guide educational planners, like science curriculum planners and school administrators to accommodate the reality of modern education trend. This

can be achieved by encouraging the teachers to use cooperative and laboratory method in their teaching and learning processes.

Professional bodies such as Teachers Registration Council of Nigeria (TRCN) can benefit from the findings of this study in training their prospective members on the effective use of cooperative and laboratory method. These bodies can encourage professional teachers in using instructional strategies like cooperative and laboratory methods which enhance students' performance.

Associations like Science Teachers Association of Nigeria (STAN) can benefit from the findings of this study by organizing seminars and workshops to their prospective members on the effective use of instructional strategies like cooperative and laboratory method on enhancing learner centred strategies. These associations can encourage teachers and supervisors in using alternative instructional strategies like cooperative and laboratory method which aid students' performance and retention Cooperative and laboratory method will be adopted in this study to teach the concept of acid and base. The use of cooperative and laboratory method in enhancing development of skills that encourage the learning of abstract and concrete concepts in line with student centred approach will be considered appropriately in this study in order to make students more active.

The research will be of benefit to students by encouraging teachers to actively involve them during the teaching and learning process. In addition to this, students can make their own decision by voicing out their understanding of a particular learning situation.

Fellow researchers in the fields of curriculum and science education will benefit from the finding of this study. The finding will add to the existing literature and also serve as a foundation for further studies in the fields.

Text book authors or writers/publishers can benefit from this study by using part of the study literature and also by sharing the findings of the research to the wider community. This will enable their readers to adopt modern learning strategies like cooperative and laboratory method in their teaching/learning activities.

In the same vein, the study is of significance to ministry of education at both state and federal level. The ministries can use the findings of this study in enhancing the quality of teaching methods which can change the trend of teaching/learning from teacher –centred to learner –centred approach. Also the monitoring and the supervisory units of the ministries can use the findings to improve the quality of their work in secondary schools.

1.8 Scope of the Study

This study examined the effects of cooperative and laboratory method on performance and retention of students in chemistry in secondary schools in Jigawa state. The study was delimited to two instructional strategies, that is, cooperative and laboratory method. The study only considered the two independent variables that is, cooperative strategy and laboratory method on performance and retention ability of students in chemistry compared to lecture method. Only public senior secondary schools (SSII) students were used for the study. These category of students are stable because senior secondary III students are busy preparing for their final examinations, while the senior secondary one (SSI) are new and not properly settle in the senior secondary school section. Other variables of the study include acid and base, and students' performance. The study is limited to Senior Secondary school two (II) chemistry students of Kazaure Education zone, Jigawa state, Nigeria. The study covered a duration of twelve weeks, that is for both administering the instrument and for conducting the pretest and retention tests as well.

CHAPTER TWO
REVIEW OF RELATED LITERATURE

2.1 Introduction

The study is aimed at investigating the effects of cooperative and laboratory method on performance and retention among secondary school chemistry students in Jigawa state, Nigeria. This chapter reviews literature based on the following sub - headings: introduction, theoretical framework, conceptual framework, concept of chemistry, concept of instructional strategy, concept of cooperative instructional strategy, concept of laboratory method, concept of academic performance, concept of retention, chemistry as a science subject in senior secondary schools, chemistry national curriculum, science teaching methods at secondary school, the choice of appropriate instructional strategy, cooperative instructional strategy, different models of cooperative learning strategy, rationale for adopting cooperative instructional strategy, laboratory method, rationale for adopting laboratory method, traditional teaching method, acid and base concept of chemistry, students' academic performance, retention of Learning Concepts in chemistry, cooperative and laboratory method, and academic performance in chemistry, cooperative instructional strategy and academic performance, laboratory method and academic performance, empirical studies and summary.

2.2 Theoretical Framework

The theoretical framework for this study is based on the constructivist theory of learning and cultural-historical activity theory.These theories are relevant to the variables in the study. The details of the theories are as follows:

2.2.1 Constructivist Theory

The proponents of this theory include John Dewey, Jean Piaget, Jerome Bruner and

Vygotsky/John Dewey -1933/1998 are often cited as the philosophical founders of this approach. Bruner -1990 and Piaget -1972 are considered the chief theorists among the cognitive constructivists, while Vygotsky -1978 is the major theorist among the social constructivists. Constructivism is basically a theory based on observation and scientific study about how people learn. It says that people construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences (WNET, 2017).The theory is about people using their experiences and cognitive ability to solve problems, learn skills or concepts. Learners use their senses to actively construct new ideas using the existing knowledge and skills. Constructivism is a major learning theory, and is particularly applicable to the teaching and learning of science. It is basically a theory -based on observation and scientific study about how people learn.

Elements of Constructivism

The constructivist theory operates on some parameters which are referred to as elements of constructivist.The American Association for the Advancement of Science (2011), stated that there are eight elements that underline the constructivist learning which are;

1. Learning is an active process in which the learner uses sensory input and constructs meaning out of it.
2. People learn to learn as they learn: learning consists both of constructing meaning and constructing systems of meaning.
3. The crucial action of constructing meaning is mental: it happens as reflective activity in the mind. Physical actions, hands-on experience may be necessary for learning, especially for children, but it is not sufficient; we need to provide activities which engage the mind as well as the hands

4. Learning involves language: the language we use influences learning.
5. Learning is a social activity: Our learning is intimately associated with our connection with other human beings, our teachers, our peers, our family as well as casual acquaintances.
6. Learning is contextual: We learn in relationship to what else we know and believe.
7. One needs knowledge to learn: it is not possible to assimilate new knowledge without having some structure developed from previous knowledge to build on.
8. It takes time to learn: learning is not instantaneous.

In constructivism, when concepts are presented as wholes, students seek to make meaning by breaking the wholes into parts that they can see and understand; they construct (constructivism) the process and understanding rather than having it done for them. This process can only be successful with the guide and support from the teacher. Piaget suggested that through accommodation and assimilation, individuals construct new knowledge from their experiences (Herr, 2016). This study is based on the cognitive theory of learning and Dewey's idea of influential education suggests that education must engage with and enlarge experience and the exploration of thinking and reflection associated with the role of educators.The cooperative and laboratory method are used according to this theory as forms of obtaining knowledge for one self by use of mental process. Bruner in Shehu (2016), opined that the greater the students involvement in the learning process, the greater the learning. Piaget's role in the constructivist teaching suggest that we learn by expanding our knowledge by experiences which are generated through play from infancy to adulthood which are necessary for learning. Their theories are now encompassed in the broader movement of progressive education. The constructivist theory focuses on providing students with physical experiences that induce cognitive

conflict and encourage students with physical experiences. Hence, cooperative and laboratory method stimulates the development of cognitive skills (Safqat, Saeed & Mohammad, 2011).

Similarly, Kroll and Bosky cited in Suwaid (2013) opined that knowledge is acquired through the involvement with contact instead of limitation or repetition. They stressed that learning is an active constructive process and the learner is an information constructor. Therefore, cooperative and laboratory method are in line with the constructivist approach learning because they all support hands on activities. In laboratory method, students mingle with materials and apparatus in the laboratory to learn concepts and skills by performing activities. Thus students actively construct or create their own knowledge by linking new information to prior knowledge. Constructivist teachers encourage students to constantly assess how the activity is helping them gain understanding. Among the characteristics of constructivist teacher as opined by UCD (2017) is that he/she encourage students to engage in dialogue, both with the teacher and with one another and support student inquiry by asking thoughtful, open-ended questions and encouraging students to ask questions of one another. By questioning themselves and their strategies, students in the constructivist classroom ideally become "expert learners." This gives them ever-broadening tools to keep learning. This idea is in line with cooperative strategy which allow learners to work together and help each other. As it is there in the constructivist ideology that learning is a social activity, the cooperative strategy encourages social interaction and the spirit of team building during learning. With a well-planned classroom environment, the students learn how to do things by themselves under the guidance of the teacher. This means that performance and retention are better achieved when students are exposed to concrete ideas than

abstract ideas, or rather when they use their past experience to solve the problem/task presented.

Constructivist learning theory statesthat learning is an active process of creating meaning from different experiences. In other words, students will learn best by trying to make sense of something on their own with the teacher as a guide to help them along the way (Brooks in Shehu, 2016). The constructivist advocates the use of activity –oriented instructional strategies to teach science subject, chemistry inclusive. Their instructional strategies include among others; discovery, experimental, laboratory, collaborative, project –based, tasked –based and cooperative strategies. Therefore, the selection of the most suitable teaching strategy is the basic condition for successful teaching/learning process because learning scientific concepts and methods involves understanding and conceptual linkage of various scientific representations.

Cooperative strategy and laboratory method, are offshoot of Constructivism, as they incorporate the idea that the best learning occurs when students are actively engaged in the learning process and working in collaboration with other students to accomplish a shared goal (Idea, 2006). While Constructivism focuses on personal experience as the foundation for learning new materials, cooperative and laboratory learning also utilizes student's own experience to solidify knowledge, in collaboration with others. The theory emphasizes the importance of interactivity with respect to the design and implementation of lesson plans.

Relevant of Constructivist Theory to the Present Study

The cooperative and laboratory method have necessary provision for students with ideas and evidences so as to enable them link the learning of chemistry concepts to real life situations. The reason for using this constructivist strategies is because

chemistry is complex and abstract, hence students need to participate in cooperative and practical activities to appreciate the scientific skills and processes. Both cooperative and laboratory method allows the students to work together in groups by sharing knowledge and skills under the guidance of the teacher. Moreover, Sternberg and Williams cited in Weibell (2011) opined thatgood teaching from a constructivist perspective depends on the effective combination of specific strategies/methods. They further stressed that teaching methods like cooperative and laboratory methods are constructivist in nature.

However, the critics of this theory are of the opinion that constructivism has been criticized on various grounds. Hirsch (2017) stressed that some of the charges critics level against it are;

1. It's elitist. Critics say that constructivism and other "progressive" educational theories have been most successful with children from privileged backgrounds who are fortunate in having outstanding teachers, committed parents, and rich home environments. This means that students from high socio-economic status have a better chance to succeed in teaching/learning.
2. Social constructivism leads to "group think. This indicate that good and talkative students might have a better chance to dominate the discussion process. This will make the slow learners to be at disadvantage during the learning activities.
3. Lack of constant and individualized evaluation. Students in constructivist classrooms may be lagging behind those in more traditional classrooms in basic skills.

If teachers support and guide, facilitate and organize the lesson very well, these critics might be overcome. This theory guides the present study in the sense that it allows learners to use their experience and abilities to solve problems on ground

which is advocated by cooperative and laboratory method. The students' commitments, government and community involvement may aid constructivist learning on track.

2.2.2 Cultural-Historical Activity Theory (CHAT)

In teaching /learning, there is always an interaction between the teacher, learners and the activities. Based on this, the cultural/historical background plays an important role on individuals learning. This theory has to do with what people think or have in mind about an activity during teaching/learning situation. The idea of this theory is rooted in the dialectical psychology of Vygotsky and Leont'ev in 1978.Cultural-historical activity theory (CHAT) is a cross-disciplinary framework for studying how humans purposefully transform natural and social reality, including themselves, as an ongoing culturally and historically situated, materially and socially mediated process (Roth, Radford & LaCroix, 2012). As students work together to solve problems, learn concept or skills, a lot of action and reactions takes place in their minds and outside which might be noticed during the interaction. Their history and culture have a great influence on the way the act, behave and learn concepts. These theorist, brings about the notion of history and culture in the understanding of human activity.

History and culture are vital instruments to human activities, therefore CHAT has a place in helping students to learn concepts in schools and beyond. Cultural-historical activity theory (CHAT) is one of several practice-based approaches that provides a robust framework for analyzing professional work practices, including teaching and learning (Julkunen, 2011, 2013). In teaching and learning, the need of the learner is considered as an important element to achieving the educational goal. Therefore the social, intellectual, physical, emotional and so forth are to be considered. These needs have a direct link with ones' culture as it points to the premise that humans are

enculturated, and everything people do is shaped by and draws upon their cultural values and resources. Culture is attached to history which evolves over time, therefore analyses of what people do at any point in time must be viewed in light of the historical trajectories in which their actions take place (Foot, 2014). Theory is used in this label to denote a theoretical framework for understanding and explaining human activity in terms of teaching and learning, by analyzing the elements of the theory.

Elements of Cultural-Historical Activity Theory (CHAT)

Activity theory adds value to assessment processes in that it suggests that the combined foundational elements of an activity are the unit of analysis that represents the minimum elements of an object-oriented, collective, and culturally mediated human activity (Engestrom in Koszalka, 2017). The main focus of any activity is in the production of an outcome (object), physical or mental.CHAT centers on three core elements:

1. humans act collectively, learn by doing, and communicate in and via their actions;
2. humans make, employ, and adapt tools of all kinds to learn and communicate; and
3. community is central to the process of making and interpreting meaning—and thus to all forms of learning, communicating, and acting (Vygotsky in Koszalka, 2017).

As people work, play, think and solve problems together, they demonstrate an accumulated set of habits and values. These habits and values are related to the way people act, communicate and learn.

Relevance of CHAT to the Present Study

This theory emphasized on human working collecting by communicating and acting, and sometimes uses tools to manipulate situations. In teaching/learning, these

involves the use of materials, methods/strategies to solve problems in groups in order to achieve a particular goal or objective.

Cooperative and laboratory method are in line with this theory because they encourage learners to work together using tools and other materials with the support of the teacher. Cooperative strategy allows learners to work together, communicate and help each other during teaching and learning under the support and guidance of the teacher. Laboratory method allow the students to work using apparatus and materials to solve problems, learn concepts and skills in the laboratory. Meyers (2007) in support of this theory opined that learning is not an isolated act; rather it is situated in time and space and influenced by the surrounding factors, resources and behavioral constraints. In view of this, the theory is related to the present study because learning about acid and base by using cooperative and laboratory method influence students' interaction, working with apparatus/materials by using their hands/brains which plays a fundamental role in development of cognition. Luis in Roth et-al (2012), stated that "As I moved from culture to culture and from country to country, it became clear for me that cultures influence the way we think about the world". As this study is about students' performance and retention ability in chemistry, as such CHAT becomes an important and relevant theory to support the present study. This is because the present study investigates the effects of cooperative and laboratory method on performance and retention of students in chemistry. The relationship between culture and the way people think can actually be a basis of cognition in teaching and learning.

However, this theory has some challenges, and the major ones are that of language and change. Michael and Luis when working with CHAT explained thathistoricity and temporality in learning and change is a great challenge in working with CHAT,

and they added that the language that we currently have available leads us to entities like: I am, you are, this is. All of these terms reify entities. They don't highlight process (Roth et-al, 2012). As human beings work and learn, they completely change or advanced to a new status. Therefore, they are supposed to be addressed as new beings so that their new status will be reflected.

The fact that this theory has been translated into many languages, there is every tendency that some aspects might be misinterpreted or misunderstood. Against all odds, the success of CHAT has always been associated with its authors' deep engagement with theoretical and philosophical issues and its most remarkable practical applications directly resulted from such an engagement. This theory is related to the present study because working together in a Jigsaw cooperative strategy involve students working together, helping each other by using their cognate ability and social skills with the support from the teacher. Related to this, laboratory method allows students to learn using materials and apparatus to learn concepts/skills by using their minds during the activities as advocated by CHAT.

2.3 Conceptual Framework

The conceptual framework for this study is based on cooperative instructional strategy, laboratory-based instructional strategy, performance and retention ability of students in chemistry. As teaching and learning process is now shifting from the traditional to the modern trend of learner -centred approach, cooperative and laboratory method are among the modern trend based on the constructivist approach in which the students have ownership of their learning. Cooperative strategy allows students to work together in small groups by helping each other under the guidance of the teacher. This strategy brings about the spirit of team work and cooperation among the learners. The laboratory method on the other hand,

encourages learners to work with materials and apparatus in an environment called the laboratory, which is different from the conventional classroom situation.

In contrary to the two strategies stated above, the lecture method which is also known as the tradition or conventional approach to teaching, is a popular method used by many teachers in teaching science subjects in secondary schools (chemistry inclusive). It is a teaching technique in which one person, usually the teacher, a spoken discourse on a particular subject (Aminu, 2010). In this method, it is assumed that the teacher has all the knowledge of the chemistry concepts, and he does all the talking and students do all the listening. Meaning that teachers are active while students are passive listeners. Based on this premise, the study is going to compare the cooperative and laboratory method vis-à-vis lecture method on students' performance and retention in chemistry in order to determine the effectiveness of these strategies in learning the concept of acid and base.

2.3.1 Concept of Chemistry

Chemistry is considered as a very important branch of science which prepare students to take science as a career in the future. It is actually among the basic foundation careers and professions. Chemistry is regarded as the "central science" or the "mother of all sciences" owing to its confluence and influence (Ahiakwa in Goje, 2014). Therefore, chemistry is an important basic science in our senior secondary schools.

Chemistry as a concept cut across all the areas of scientific studies. Jimoh (2006) defined chemistry as the science that deals with structure and composition of matter. McDuell (2011), sees chemistry as the study of materials and how we can change them to make new more useful materials. This is regarded as the basis of chemical industries, as many chemist work in chemical industries that are involved in making

useful products from raw materials. Jack (2006) defined chemistry as a body of knowledge and way of thinking.

Considering the above definitions of chemistry, it is therefore necessary for secondary school students to be familiar with basic concepts of chemistry in order to prepare them as successful future scientists and to make them a very useful members of their communities. Concept like that of acid and base is a very important aspect of chemistry as we come across it in our daily lives. We can see acids and bases in medicines, plastics, soaps, paints, food additives, fertilizers, pesticides and so forth. For secondary school students to be familiar with the various concept of chemistry as it is there in the national chemistry curriculum, teachers need to employ suitable instructional strategies in teaching chemistry as a science subject in our secondary schools.

2.3.2 Concept of Instructional Strategy

In teaching and learning the concept of strategy, method and technique are often used interchangeably, even though strategy has a wider coverage. Alake (2015), sees instructional strategy as a set of unique activities which the teachers employ to implement a particular teaching method it is also a specific way of presenting instructional materials. Instructional strategies are techniques teachers use to help students become independent, strategic learners (Alberta Learning, 2017). These strategies become learning strategies when students independently select the appropriate ones and use them effectively to accomplish tasks or meet goals.

The combination of techniques and methodsthat a teacher can adopt to meet the various learning objectives are regarded as instructional strategies. These strategies help students to walk on the path of independent learning and become strategic

learners. According to Alberta (2017), instructional strategy can help students in the following ways:

1. motivate and help them focus attention
2. organize information for understanding and remembering
3. monitor and assess learning

Therefore, instructional strategies like cooperative and laboratory methodemploy step-by-step strategy instruction anda variety of instructional approaches and learning materials which help studentsto become successful strategic learners.

2.3.3 Concept of Cooperative Instructional Strategy

Cooperative learning strategy is an instruction strategy where students are put in small groups to work together in order to achieve a common goal under the guidance of the teacher. Effective science teaching demands that students are given the opportunity to interact with one another in order to control their learning environment. Piaget (Mari in Abdullahi, 2014) opined that intelligence develops not by virtue of operation alone, but also as a result of interaction of the learners with one another and with their learning environment. Therefore, cooperative learning strategy is one of the effective instructional strategy for teaching chemistry concepts in secondary schools, because it enables the learner to be exposed to the learning situation under the guidance and support of the teacher. Students in small heterogeneous groups take roles and learn to share knowledge and tasks with one another through a variety of structures with this strategy (CTAC & WCSD, 2015). While different experts categorize these differently, common features of effective cooperative learning include team building, positive interdependence, group interaction, structured activity, and individual accountability.

Olorukooba (2001) opined that cooperative learning is based on the premise that an individual can only achieve his/her goals, if other members of the group with whom he/she is learning can equally attain their goals. In the same vein, Eniayeju cited in Sadi (2014) described cooperative strategy as a discovery method in which small groups are used during the teaching and learning process. The members of the groups mingle together in a spirit of team work to attain a common goal. Cooperative learning is an approach to group work that minimizes the occurrence of those unpleasant situations and maximizes the learning and satisfaction that result from working together as a team. In this regard, Joshi (2018) opined thatCooperative learning is a teaching strategy in which there are small teams – each with students of different levels and ability that use different learning activities to improve their understanding of the assignment or a task. For an effective cooperative learning classroom, students must be given awareness on cooperative work. Groups should be heterogeneous in nature. The recommended grouping is medium and high or medium and low ability groups. The strategy can therefore be applied to teach chemistry concepts like that of acid and base in order to have a better understanding or rather performance and retention of the concepts.

2.3.4 Concept of Laboratory method

Laboratory method, encourages students to learn in an environment which differs from a conventional classroom setting. In subjects like chemistry, students feel science and behave scientifically when they are working in the laboratory. Alaka (2015), opined that laboratory Method isempirical learning through direct involvement of students**.** Laboratory method is the instructional strategy in which the students work with apparatus and materials in a functioning laboratory. This can only take place when there is clear instructions and proper support from the teacher

with the help of the laboratory technician. It is a practical as well as activity based strategy to learning of chemistry, and the method is learner friendly. Hart, Mulhall, Berry, Loughran, and Gunstone (2000) suggested that students enjoy laboratory work because it is more active and it involve the students working with materials. In the laboratory, students have a chance to engage in hands-on activities, especially in secondary school chemistry where by students are learning basic scientific skills in order to become future scientist. Despite some reservations, many authors believe that laboratory work helps promote conceptual understanding (Hart et al., 2000; Özmen; Demircioğlu & Coll, 2009; Woodley, 2009). It builds in the students' scientific skills and processes especially in learning chemistry as a science subject in secondary schools.

However, in the laboratory method, students interact with learning materials under the guidance of the teacher. While in the cooperative learning strategy, students work together mingles with one another in the spirit of team work for the attainment of a common goal. These situations help the students to have greater performance and retention of the basic chemistry concepts.

2.3.5 Concept of Academic Performance

Educational performance is about meeting an educational goal which may be for a long term or short term. Sometimes it may mean finishing a particular educational programme like NCE, diploma, degree etc. In specific terms, academic performance has to do with students' scores after conducting a test or examination. Achino in Shehu (2016) considered academic performance to the level of an individual's educational growth in a test when compared with scores of others of the same level. Related to this, Yusuf (2018) opined that performance measures the aspect of behavior that can be observed at a specific period. Academic performance is a

situation when students are required to maintain a satisfactory record and meet the obligations of the courses in which they are enrolled (Harvard University, 2015). In a similar situation, Ali, Haiter, Munir, Khan and Ahmed (2015) have simply put academic performance as grades/marks one obtains in a given subject after an instruction. Inyang in Goje (2014), defined academic performance as assessment of how much pupils have learnt or has attained after a learning period. In the same vein, Jayanthi,Balakrishnan, Ching, Latiff, and Nasirudeen, (2014) opined that academic performance was characterized by the overall performance in each year which culminates in a Grade Point Average (GPA). However, Topor, Keane, Shelton and Kalkins (2010), have said that several methods are used to measure students' academic performance, including standardize achievement test scores, teacher rating of academic performance and report card grades. In this study the performance scores of experimental groups and the performance scores of the control group are going to be investigated.

For long, educators have continued to call for the need of the different modes of teaching that promote performance in students (Lawson & Thompson, Esiobu & Soyibo, cited in Goje 2014; Okapor & Okeke, 2006; Okoye & Okeke, 2007). Lawson and Thompson in Goje (2014) further observed that students' achievement in science (chemistry inclusive) depends on their understanding of science concepts. This calls for involving students for cooperative and laboratory method.

In related development, Alake (2015) defined academic performance as the overall measure of performance of students in a given test after a period of teaching. Academic performance has to do with cognitive ability or rather the students' scores after conducting assignment, a test or examination. Achino cited in Shehu (2016) considered academic performance to the level of an individual's educational growth

in a test when compared with scores of others of the same level. That is in this study the performance score of experimental groups and the performance of the control group is going to be investigated. Performance in this study therefore refers to the ability of the chemistry students to score marks after being exposed to the treatment on acid and base concepts. This calls for involving students for cooperative and laboratory method to find out their effects on performance of students in chemistry.

2.3.6 Concept of Retention

Retention on the other hand, is the ability of the learners to recall information, ideas or learning activities at a later time which he/she may be ask to mention, write or remember after some times. Bichi (2001) defined retention as the ability to maintain and later recall information or knowledge gained after learning. Alake (2015) sees retention as the ability to store information which can be easily recalled from the short term memory and long term memory. Olarewaju (2012) opined that retention is the ability to store information which can be easily recalled from the short term memory and long term memory. In the same vein,Suleiman in Olarewaju, (2012) reported that better retention and recall of what is learned is achieved as more senses are involved, more so, as students see and do things by themselves. Therefore, retention is a very important aspect of students learning or rather an aspect of measuring the cognitive ability of learners.

As standardized test is used for testing performance, so is retention test used for measuring retention ability of students. A retention test occurs after learning has taken place . Usually the subject is brought back at varying time periods usually days, or weeks after the learning the task to determine how much the client /student

has retained (Magnuson, 2004). The more a subject has retained the more effective the condition or variable was in learning the task. Some teaching strategies can make students perform during examination, while others can aid retention ability at a later time. Therefore this study considered cooperative and laboratorymethodies on performance and retention of students in learning the concept of acid and base in chemistry at secondary school level.

2.4 Chemistry as a Science Subject in Senior Secondary Schools

The teaching/learning of science education in our secondary schools is highly placed and recognized for producing future scientist and preparing scientist to become productive members of their society. Chemistry has been identified as a very important science subject and its importance in scientific and technological development of any nation has been widely reported. It was as a result of the recognition given to Chemistry in the development of the individual and the nation that it was made a core – subject among the natural sciences and other science – related courses in Nigerian education system (Adesoji & Olatunbosun, 2008). It has been a pre-requisite subject for offering most science oriented courses in the tertiary institution and this calls for the need in teaching it effectively.

The study of chemistry as a science subject in senior secondary schools prepare the learners to become future scientist through both theoretical and practical aspects of learning experiences. For student to make a choice in tertiary institutions courses like medicine, engineering, pharmacist, bio-chemistry, geology, laboratory technologist and so forth, he/she must pass senior secondary school chemistry at credit level. In regard to this, the National Policy on Education stressed that secondary education shall prepare individual for useful living within the society and higher education (FRN, 2013).

On this note, knowledge of chemistry is necessary for all health and health allied profession, geochemistry, environmental science and molecular biology. Teaching and learning of chemistry at secondary school level will prepare students into professional future scientist and undergraduate programmes which will pave way to production of professional chemistry teachers.

Chemistry teaching is supposed to be result oriented and students centred, and this can only be achieved when students are willing and the teachers are favourably disposed, using the appropriate methods and resources in teaching the students (Adesoji & Olatunbosun, 2008). It is therefore important to look for a better teaching strategies like cooperative and laboratory method which are all learner centred oriented. Students by nature are curious; they need to be actively involved in the learning process in which they are continuously equipping, testing, speculating and building their own personal construct and knowledge (Edomwonyi-otu & Avaa,2011). This happened often in chemistry lessons because students are given opportunities to mingle with materials and sometimes to work together especially when teachers are using instructional strategies like cooperative and laboratory – based styles. When knowledge of chemistry is personalized in this nature, it becomes valid, meaningful and useful to the students. In chemistry, students need to actively construct their own personal awareness and meaning (Nbina, 2014). To substantiate the argument, Usman in Goje (2014), remarked that the brain is not a passive consumer of information and to learn with understanding, a learner must actively construct meaning of what to be learned.Science subjects like physics and chemistry are generally regarded as difficult or abstract subjects. This may have influenced why a few opt for them except biology at the senior secondary level compared to subjects in arts and social sciences. This is why some student most especially at secondary school level look at chemistry as a very comprehensive and difficult subject.

Despite the prime position chemistry occupies in our educational system and the efforts made by researchers to enhance performance, students' performance in chemistry and sciences in general are still low (Adesoji & Olatunbosun, 2008). They

stressed that the reasons identified for this failure are laboratory inadequacy, teachers' attitude, examination malpractice, time constraint for conduction of practice's, non-coverage of syllabus, class size, non-professionalism and environment. The issue of professionalism is usually connected to teachers' qualification and expertise, and this has direct link with the choice of appropriate strategy in teaching and learning. Hence the need for cooperative and laboratory method in improving students' performance and retention in chemistry teaching. Therefore, the teaching of chemistry as a science subject in our secondary schools is aimed at giving the students the opportunity to gain meaningful learning, acquire appropriate skills and attitudes that enable them live and contribute to the development of the society.

2.4.1 Chemistry National Curriculum

The word curriculum is not an easy one to define, though many authors have attempted to define it in one form or the other. Guga and Bawa (2015), opined that curriculum as a special area of study emerged from the need to arrange, organize and translate educational vision into educational programme. This implies that curriculum is about putting the national educational plan into achievable programme. Yusuf (2012) define curriculum as a goal or set of values that is activated through planned and development. Curriculum has also been defined as the plan and guided learning experience and intended outcome formulated through systematic reconstruction of knowledge and experience under the auspices of the school for the learners continuous and willful growth and social competence (Tanner & Tanner in Ben-Yunusa, 2008). This means that for a curriculum to be effective there should be planning and development. The planning and the development should be geared toward achieving individual and the societal needs. Chemistry is a

subject taught at senior secondary schools with its curriculum purposely designed to achieve the objectives of chemistry programme in Nigeria education system. The curriculum has been developed by the federal ministry of education (FME) through the Nigerian Educational Research and Development Coucil (NERDC) for SSI, SSII and SSIII. The curriculum is aimed at satisfying the chemistry requirements for the senior secondary school programme in the National Policy on Education (FRN, 2013). In the same vein, the chemistry curriculum was structured into major themes for each stage as given below:

Senior Secondary School one (SSI)

1. Chemistry and industry
2. The chemical world
3. Chemistry and environment
4. The chemistry of life

Senior Secondary School two (SSII)

1. The chemical world
2. Chemistry and environment
3. Chemistry and industry
4. Chemistry of life

Senior Secondary School three (SSIII)

1. Chemical world
2. Chemistry and industry
3. Chemistry of life

However, at each stage these themes provide the basis for the topics organized sequentially into units which are supposed to be treated in details. It includes teaching topic, performance objectives, content, activities, teaching and learning

materials and evaluation guide. It is recommended in the curriculum that a teaching strategy which rested on the activity of the learners should be employed. This is adopted so that the learners are used to the scientific skills and processes. "No matter how the curriculum is used, the basic elements of chemistry as an experimental science must not be compromised" (FME, 2007). The chemistry curriculum encouraged teachers to enrich the content with relevant materials and information from their immediate environment.

For students to take career in science, he/she must study basic sciences at senior secondary school level among which chemistry is inclusive. The National Policy on Education stressed that chemistry is one of the optional subjects in science classes in Nigerian senior secondary schools (FRN, 2013). Therefore, the curriculum provides a basis for preparing secondary school chemistry students to study chemistry and other related science courses at higher level in order to take a career in science and technology.

2.5 Science Teaching Methods at Secondary School Level

There are several methods of teaching and learning science subject in secondary schools which involve the presenting of scientific facts, information, principles, and skills on concepts to the students. Some of the methods include: Cooperative, demonstration, inquiry, discovery, discussion, project, laboratory, individualized, fieldtrip, excursion and lecture / direct expository methods and so forth. Some of these methods which have their characteristic advantages and disadvantages are specific for some situation and categories of students, while other can generally be applied to all categories of students (Atadoga & Onaolopo, 2008).

Teaching and learning of science at secondary school level usually prepare students in developing curiosity, problem solving skills and the agitation to find out facts by

themselves, hence preparing them for the challenge a head as future scientist. Based on this, the Federal Government of Nigeria emphasized the teaching of science at all levels of our education most especially the secondary level being the foundation of basic science education like chemistry, biology, physics and mathematics. This is to enable citizen acquire knowledge of their environment, develop problem solving skills, develop desirable scientific attitudes, as well as increase their understanding of the role and functions of science education in everyday life (FRN, 2012). This can successfully be achieved when students are allowed to work together in a very good learning environment like laboratory and a conducive classroom where learners have space and freedom of learning. Therefore, cooperative and laboratory method can be effective instructional strategies towards achieving a functioning scientific process.

The curriculum is the master document which geared teaching/learning at all educational level. In the Nigeria situation, the first National Curriculum Conference was organized in 1969 with the aim of modernizing science education content and instruction. To reflects this pedagogical triumph, such attempt according to Akpan in Shehu (2016) have been made through programmes like the Nigeria Integrated Science Project (NISP) by the science Teacher Association of Nigeria (STAN), National Science Quiz Project (NSQP), National Mathematics Improvement Project (NMIP) by the National Mathematical Centre and National Secondary School Science Project (NSSSP) which was a project of the comparative education study and adaptation centre (CESAC) Now Nigeria Educational Research and Development Council (NERDC). This programmes and organizations tried over the years to make ends meet in improving the teaching and learning of science subjects particularly at secondary school level. The organizations are involved in provision of policy documents, improving learning environment and most importantly embarking

on human resource development. Therefore, teacher development training most especially on teaching methodology is of great concern to both governmental and non-governmental agencies in Nigeria.

However, teaching method is a way, a path or an avenue for achieving the educational goal by helping the learner change for the betterment of himself and the society at large. Teaching method is not an end in itself, but a means to an end. A good and effective teaching method lead in achieving the instructional objectives. Many authors attempt to discuss on methods, and for the purpose of discussion, these methods are classified to reflect either traditional or activity-based instructions. The former is teacher centred while the latter is learner centred.

The current trend in secondary schools is more of the traditional method which is the lecture method. Based on this, Aina (2009) opined that the lecture (traditional) method is predominately used in our educational institution. The lecture method is a traditional method of transmission of knowledge to learners characterized as one – way flow of information from the teacher who is always active to the learner who is always passive (Sola & Ojo, 2007). The method is the most frequently used method of instruction (Suleiman, 2010). The method does not involve students for cooperation and laboratory activities. This research work is aimed at finding a better teaching methods which deviate from the current trend by investigating the effects of cooperative and laboratory method on performance and retention among chemistry secondary school students.

2.5.1 The Choice of Appropriate Instructional Methods

Instructional procedures have changed over the years due to changes in education which is greatly influence by rapid development in science and technology. These procedures mostly take place in the classroom and the laboratory. Effective

classroom and laboratory procedures maximize opportunities for students to learn and interact positively with each other and with learning materials. Reviewing the keys to good room arrangement will help the teacher design a plan that meets the philosophy of the teacher, considers the placement of essential materials to maximize learning opportunities, and meets the requirement of special needs students (Lechtenberger & Hettler, 2016).

A good and effective teacher is the one who think and plan a head of time especially on the choice of teaching methods. The teacher should always think of finding and using the appropriate strategies which will help in improving students' performance and retention ability especially at secondary level. The modern day instructional process should be more centered on students, and teachers should take the role of facilitators and guides instead of being mere providers of knowledge. They must ensure that they engage their students in learning and provide effective instruction using a variety of instructional methods and following different pedagogical approaches aided with technology (Saxena, 2016). Teachers should be active participants in their own learning and must seek out professional development in order to be guided on the choice of the appropriate instructional strategies and to improve the students' performance and retention.

In related development, teaching methods can also influence the students' performance positively or negatively. Olorukooba (2001) reported that students taught using cooperative learning in science teaching have the positive attitude which aid performance and retention based on the educational benefit derived from group work. Akpan in Shehu (2016), observed that the recognition of the superiority of activity – based instructional method over other methods has resulted in the recommendations of the science process skills approach to science teaching as a

method of instruction in science classes. Science teachers have to consider certain factors in selecting instructional methods for teaching science, as rightly observed by Atadoga and Onaolopa (2008: 67) as follows:

i. the learners' age, previous knowledge on the topic and general ability. Science teacher must bear in mind that the class may not be homogenous in ability but mixed;
ii. the topic to be taught, the content of the topic including the concepts to be taught must be well understood to make the choice of an appropriate method easier;
iii. the science teacher's effectiveness in handling a particular method. Whatever advantage a method may have, if the teacher is not competent to use it, the students may suffer unduly;
iv. the timing of the lesson is also very important. For afternoon lessons methods that will make the students to participate actively are advocated so that students can be alert and attentive;
v. the class size is a very serious factor in the choice of method of teaching. For example,choosing a demonstration method for a class of over one hundred students is suicidal, because the teacher will not be able to control or direct the class appropriately; and
vi. the available resource at the teacher's disposal will be an important determinant in the choice of teaching method

A teacher can be conversant with this process if he or she is up to date with the Information and Communication Technology and is regularly involved in teacher professional development training. It is important for teachers to be flexible in the choice of their instructional methods, depending on the situation. Rigidity does not pay well in learning because of the human nature. Atadoga and Onaolapo (2008)

observed that, it is very clear that science teachers cannot be dogmatic in their daily choice of methods of teaching. A science teacher may introduce a lesson with a method, goes on to develop the lesson by one or more other methods and ends the lesson employing a different method. The frequency with the teacher changing his/her method of teaching will depend on the concepts, skills or the cognitive ability needs to be developed in the students. In this study; the cooperative and laboratory method are going to be used to determine the performance and retention ability of secondary school chemistry students.

2.6 Cooperative Instructional Strategy

Cooperative instructional strategy allows students to work together during the teaching and learning process. Students are given freedom to interact, help and support one another with the support of the teacher throughout the learning process. Students work in small heterogeneous groups and this group work, according to Brame and Biel (2015) is formally termed cooperative learning.Olorukooba (2001) opined that cooperative learning is based on the premise that an individual can only achieve his/her goals, if other members of the group with whom he/she is learning can equally attain their goals. Eniaiyeju (2001) described cooperative strategy as a strategy in which small groups are used.Cooperative learning is an approach to group work that minimizes the occurrence of those unpleasant situations and maximizes the learning and satisfaction that result from working together as a team.Cooperative learning, according to Kose, Sahin, Ergun and Gezer (2010) is an educational process in which speaking, listening, writing and reflection as a crucial tool of active learning take place. The strategy demand students to use their social skills and to work with peers, which in the long run contribute to the development of their cognitive learning outcomes (Johnson & Johnson in Abdullahi, 2014).

Cooperative instructional strategy involves instructional use of small groups of students working together to achieve a common learning goal. In this regard, Kose et al. (2010) add that in a cooperative learning setting, each individual in a group bears his or her individual responsibilities while carrying other responsibilities toward group achievement. Cooperative learning strategy involves dividing a class into small groups of 2-5 learners (Sarah and Cassidy, in Sadi 2014). Cooperative learning therefore allows students in small groups to work and communicate with each other. Looking at the above statement, it is clear that this method can work in teaching science subject like chemistry.

However, the current conceptual change in instructional strategies recognizes the importance of student-student verbal interaction during the learning process, and that cooperative learning may provide the necessary steps to encourage these strategies. Johnson, Johnson and Holubec in Abdullahi (2014), defines it as the instructional use of small groups so that students work together to maximize their own and each other's learning. Cooperative learning environment support students to interact together in group in an attempt to find solution to some common task. Cooperative learning is about togetherness of individuals towards success of a common goal. An individual can only achieve his/her goals, if other members of the group with whom he/she is learning can equally attain their goals (Olorukooba, 2001). This means that success of an individual in the attainment of a common learning goal will automatically increase the chances of the success in the attainment of the same goals by other members of the group. In addition to this, Tunga (2015) stressed that students learning goal may be structured to promote cooperative, competitive or individualistic efforts. The effort of all the group members is needed in achieving a successful end. Therefore, effective science teaching demands that students are

given the opportunity to interact with material and control their learning environment.

In related development, Ransdell (2007) opined that cooperative instructional strategy is a teaching strategy in which small group use a variety of learning activities to improve their understanding of a subject. Each and every member of the group is responsible for his own learning and even the learning of other members of the group by creating an enabling environment for learning to flow.

In cooperative strategy, students work in small groups of students with varied abilities on a structured activity. Eniayeju (2010) stressed that cooperative learning is a strategy where students work collaboratively in small groups by sharing ideas while working on a given task. In addition to this, Tunga (2015), opined that cooperative learning is a teaching strategy in which students work together in small teams and use a number of activities to achieve stated objectives and improve their understanding of subject matter.

Cooperative strategy allows students to take control of the learning environment and defines teachers' roles of supporting the learners. In this regard, there is a very good rapport between students and teachers during cooperative learning. Kutneck cited in Abdullahi (2014), submits that;

> Children appear involved and well-motivated towards their school work. They are working in groups, helping one another. While they are working, they show their developing competence and confidence in learning. Along with the development of school knowledge, social sensitivities and relationships are being built up amongst the pupils. The children appear to have a remarkable depth of knowledge which they share with one another. They are not secretive about their answers with others. The teacher, if that is the appropriate term, is a guide and conversant rather than a director. Without queues around the teacher's desk, he/she can give individual attention to children where needed (p.20).

In cooperative strategy, the learners work together, share ideas and help each other during the learning activities. The teacher on the other hand, guide and support the

learners by giving clear instructs, going round the groups to listen to their discussions and watch how they approach their task and possibly advise or remind them of what they supposed to do, so that they do not go astray towards achieving their goals.

For an effective cooperative learning to occur, there should be a friendly environment where the teacher and the learners are favoured. For this strategy to function very well, four things are necessary. First, teacher(s) and students need to feel safe, and students should be ready to handle all the challenges. Second, there should be the spirit of team work and feeling of togetherness among the learners. Third groups need to be small enough that everyone can contribute. Fourth, the task students work together on must be clearly defined by the teacher.

Furthermore, Kutneck in Abdullahi (2014), outlined the following advantages for the use of cooperative strategy in which the above provision was made as follows:

i. learners actively participate;
ii. teachers become learners at times, and learners sometimes teach;
iii. respect is given to every member;
iv. projects and questions interest and challenge students;
v. diversity is celebrated, and all contributions are valued;
vi. students learn skills for resolving conflicts when they arise;
vii. members draw upon their past experience and knowledge;
viii. goals are clearly identified and used as a guide; and
ix. research tools such as internet access are made available
x. students are invested in their own learning.

In a cooperative learning environment, learnersare encouraged to be in the center of learning and learn together. Learners will not enjoy learning if it happens in

isolation. Bruner and Jerome cited in Faryadi (2007). Therefore, cooperative strategy will help learners improve their critical thinking and intellectual skills by learning from one another.

In the same vein, learner -centred environment is the key to successful cooperative learning strategy. According to Amita (2006) cooperative learning environment refers to a situation which learners with one common cause in their mind strive to achieve one common learning goal. In other words, a small dedicated group of students learn together and take advantages of each other's expertise to achieve a common goal. Cooperative learning as the process of acquiring knowledge in a socially packed environment by one or two small groups of students (George & Christopher, cited in Abdullahi 2014). They further stressed that cooperative learning is a set of principles and strategies for enhancing learner to learner communication for a common cause.

However, George and Christopher in Abdullahi (2014) metioned that there are five important value added principles of cooperative learning strategy:

1. Interdependency among the learners, they learn together and learning is part and parcel of each other, they work in a small group and plan to finish a product together. This kind of learning bears great value to all (Geri, Kemberly, & Kim, 2005). In another words they benefit from each other's knowledge;
2. each member of the group is accountable for sharing his/her knowledge with the rest of the group;
3. using their collaborative skills to help each other to learn and encourage each other to participate in problem solving and cooperative learning. As such they strive to increase overall achievements of the group;

4. equal opportunities for all, as a team, each member is responsible in taking part in the group building activity and strives for its collective success; and
5. they all learn together, interact together and transfer knowledge together.

In cooperative learning, students work together help each other for the success of the task and attainment of a common goal. Smith (2018) opined thatcarefully structured cooperative learning involves people working in teams to accomplish a common goal, under conditions that involve both positive interdependence.

Cooperative learning is an approach to group work that minimizes the occurrence of unpleasant situations and maximizes the learning and satisfaction that result from working together as a team. In related development, Johnson and Johnson in Adullahi (2014) reported that cooperative learning results in a greater effort for achievement, more positive interpersonal relationships and greater psychological health than competitive or individualistic learning efforts. Cooperative learning strategy involves dividing a class into small groups of students with different abilities. Cooperative learning therefore allows students in small groups to work and communicate with each other, and by so doing it aids learning and sprit of team work.

For an effective cooperative learning classroom, students must be given awareness on cooperative work. Groups should be heterogeneous in nature. The recommended grouping is medium and high or medium and low ability groups. When high and low ability students are grouped together, the medium ability students are left out of the group interaction (Eniayeju, in Sadi 2014). Therefore, in cooperative work teachers are more of giving support to students by encouraging them to work as a team and to arrive at a consensus during the instructional process.

Depending on the situation, there are different types of cooperative learning strategies. According to Johnson and Johnson (2008), there are three commonly recognized types of cooperative learning groups. Each type of group has its own purpose and application as follows:

1. Informal Cooperative Learning Groups:These *ad-hoc* groups may be organized "on-the-fly" as an aid in direct teaching. Informal groups are particularly useful in breaking up a lecture into shorter segments interspersed with group activity. While this method leads to less time for lecture, it will increase the amount of material retained by students as well as their comfort working with each other.
2. Formal Cooperative Learning Groups:This type of group forms the basis for most routine uses of cooperative learning. Groups are assembled for at least one class period and may stay together for several weeks working on extended projects. These groups are where students learn and become comfortable applying the different techniques of working together cooperatively.
3. Cooperative Base Groups:Cooperative base groups are long-term, stable groups that last for at least a year made up of individuals with different aptitudes and perspectives. They provide a context in which students can support each other in academics as well as in other aspects of their lives. The group members make sure everyone is completing their work and hold each other accountable for their contributions. Implementing cooperative base groups in such a way that students meet regularly for the duration of a course completing cooperative learning tasks can provide the permanent support and caring that students need "to make academic progress and develop cognitively and socially in healthy ways." These different types of cooperative learning strategies give room for the application of different models of cooperative by teachers and researchers in the field of education.

2.6.1 Different Models of Cooperative Instructional Strategy

There are various models of cooperative learning in existence which are developed by researchers and expert in the educational field. Though they look different, but the basic components and characteristics of cooperative learning strategies do not change. Some cooperative learning techniques utilize student pairing, while others utilize small groups of students. Hundreds of techniques have been created into structures to use in any content area. According to Kagan cited in Sadi (2014), the three most familiar models are jigsaw, think-pair-share and number heads together. Others, as pointed out by (Schul, 2011; Sarah & Cassady in Sadi 2014; Aziz & Hossain 2010;) are learning together (LT), teams game-tournaments (TGT), group investigation (GI) and students teams achievement divisions (STAD). These are among the most common used cooperative learning models.

1. The Jigsaw Model

Jigsawis a cooperative learning structure applicable to team assignments that call for expertise in several distinct areas. This model, according to Olorukooba in Abdullahi (2014), was developed by Elliot and derived its base on the idea that cooperation will develop each individual, and each individual can reach a goal only if all other individuals in the group reach their goals. This means that in ajigsaw classroom, interdependence is required among students and this makes it a unique learning method. It is this interdependence that encourages the students to take an active part in their learning. Learning from each other gradually diminishes the need to try to out-perform each other because one student's learning enhances the performance of the other students. In Jigsaw, students are assigned to six member teams to work on academic material that has been broken down into sections.In the teams formed, either the instructor or the team members designate which member will be

responsible for each area (Felder & Brent, 2007). For example, the concept of acid and base might be divided into meaning and types, physical properties, chemical properties and uses. Each team member reads his or her section. Next members of different teams who have studied the same sections meet in expert groups to discuss their sections. Then the students return to their teams and take turns teaching their teammates about their sections. Since the only way students can learn sections other than their own is to listen carefully to their teammates, they are motivated to support and show interest in one another's work.

Elliot used cooperative learning specifically to bring children of different races and ability together. Elliot according to Olorokooba (2001) based the theory and practice of this Jigsaw approach on social psychological research, mutual interest, coordinated efforts, trust and helpfulness amongst group members. Jigsaw is a grouping strategy in which the members of the class are organized into "jigsaw" groups. The students are then reorganized into "expert" groups containing one member from each jigsaw group. The members of the expert group work together to learn the material or solve the problem, then return to their "jigsaw" groups to share their learning. In this way, the work of the expert groups is quickly disseminated throughout the class, with each person taking responsibility for sharing a piece of the puzzle (Teacher Vision, 2016). Jigsaw can be used for sharing different solutions to the same problem or for dividing up research responsibilities.

In related development, Elliot in Abdullahi (2014) opined that jigsaw model improves academic performance among ethnic-minority pupils. Socially, there was substantial development in inter-ethnic acceptance, concern and trust. Group members also showed an increased ability in taking on other perspective in role taking and promoting social sensitivity.

Elliot proposed the following steps to be followed while adopting this model:

1 divide students into 5- or 6-person jigsaw groups. The groups should be diverse in terms of gender, ethnicity, race, and ability;

2 appoint one student from each group as the leader. Initially, this person should be the most mature student in the group;

3 divide the day's lesson into 5-6 segments corresponding to the number of the groups;

4 assign each student to learn one segment, making sure students have direct access only to their own segment;

5 give students time to read over their segment at least twice and become familiar with it. There is no need for them to memorize it;

6 form temporary "expert groups" by having one student from each jigsaw group join other students assigned to the same segment. Give students in these expert groups time to discuss the main points of their segment and to rehearse the presentations they will make to their jigsaw group;

7 bring the students back into their jigsaw groups;

8 ask each student to present her or his segment to the group. Encourage others in the group to ask questions for clarification;

9 float from group to group, observing the process. If any group is having trouble (such as, a member is dominating or disruptive), make an appropriate intervention. Eventually, it's best for the group leader to handle this task. Leaders can be trained by whispering an instruction on how to intervene, until the leader gets the hang of it; and

10 give quiz at the end of the session on the material learnt

However, the teacher's role in the jigsaw is to facilitate learning. When students are in expert groups, the teacher can support students by encouraging them to find ways

to put information they learned into their own words, to relate the material to their own lives, and to give examples that help them explain the material to their group. If a student finds it difficult to explain his or her topic to the jigsaw group, a teacher first might pair that student with a partner who will help research and present the information to the jigsaw group and then have the pair travel together to the expert group and to the jigsaw group (Teacher Vision, 2016). This will help both students develop interpersonal skills, communication skills, and cooperating. To facilitate this partner coaching, have both students tell you if this is helping them learn the material.

2. Think-pair-share

This is a method whereby students are engage in activities which will encourage them to think individually, in small groups or in pairs. Later, students will be asked to answer questions in plenary. According to Sadi (2014), the method involved four steps as follows:

a. the first step, groups of four students listen to a question posed by the teacher
b. secondly, individual students are given time to think and then write their responses
c. thirdly, pairs of students read and discuss their responses
d. finally, a few students are called on by the teacher to share their thoughts and ideas with the whole class.

This method can work in the science classroom due to the fact that science is all about predictions. This is because the method encourages thinking which help in building of ideas. In chemistry, students can be given the opportunity to formulate hypotheses about the outcome of an experiment before it is done using this model. For Example, a teacher could pose the question, 'What is an acid?' students will be given time to think individually about the question. After a couple minutes of thought the students then turn to a shoulder partner and discuss in pairs their thoughts with each other. The teacher then facilitates a whole class discussion.

3. Number Heads Together (NHT)

This model has emphasis on the members of the team putting their head together in order to accomplish a particular task. The students are numbered within the teams, and the teacher calls out the question or the problem to be solved. Groups should discuss and agree on their answer and all the members of the groups should get ready to participate actively in plenary.

According toCandler inGerrard, Collette, and Elowson (2005), opined that number heads together should have the following features:

1. Participants number off at their table group.
2. Instructor poses question.
3. Participants put their heads together to generate a common answer. They must make sure everyone on the team knows the answer. They should also be ready to supply support for their answer(s) from the text and/or from other knowledge.
4. Instructor calls a number. That person provides the response for their team

Numbered Heads Together encourages successful group functioning because all members need to know their group's answer(s) and because when participants help their team mates, they help themselves and the whole group. As such the spirit of team work is encouraged while using this model.

4. Learning Together (LT)

In this model, students are put in small groups, with each group working on assigned task. The teachers' main role is to assign the task to groups, praise and encourage the groups. Learning together, a model of cooperative learning developed by David Johnson and Roger Johnson in Abdullahi (2014), are of the view that learning together involves students working in four- or five-member heterogeneous groups on assignments. The groups hand in a single completed assignment and receive praise and rewards based on the group product. This method emphasizes team-building activities before students begin working together and regular discussions within groups about how well they are working together.

In the process, students must put heads together for the success of all the group members (Slavin, 2011). In other words, students must ensure that other members in their group complete the tasks and achieve the academic outcomes. The lesson will

not be cooperative if students do not “swim together” in the group learning activities (Johnson & Johnson, 2008). Hence, positive interaction needs to be constructed in cooperative learning groups to help students work and learn together. For learning together to be effective, according to Johnson and Johnson cited in Ghaith (2017) it should incorporate things like; instructional objectives, dividing the class into groups, giving roles to group members, helping group work, individual evaluation and evaluating the group performance.

5. Teams Game-Tournaments (TGT)

In this model, students compete with those teams who are at the same performance level. Low and high achievers from each team compete with their counterparts and the top scorers in these “tiered” tournaments win points for their teams. Here, students play academic games as representative of their team. Veloo and Md-Ali (2016) stressed that Cooperative TGT is a kind of cooperative learning which involves cooperation among students in small groups, whereby students are encouraged to help each other to accomplish a given task. Within the team, students on a similar performance level compete and coach each other prior to the game in order to ensure that all group members are competent in their subject matter. Therefore, students earn team points based on how well they do at their tournaments tables.

6. Group Investigation (GI)

In this model, students work together to produce a project, which they may have hands in selecting. Group Investigation is a general classroom organization plan in which students work in small groups using cooperative inquiry, group discussion, and cooperative planning and projects Sharan and Sharan in (Abdullahi, 2014). Group investigations are structured to emphasize higher order thinking skills such as analysis and evaluations. Students form their own groups of two- to six-member.

After choosing subtopics from a unit that the entire class is studying, the groups break their subtopics into individual tasks and carry out the activities that are necessary to prepare group reports. Each group then makes a presentation or display to communicate its findings to the entire class. According to Sharan and Sharan cited in (Haliru, 2015), group investigation has a unique character based on the integration of four basic features of investigation, interaction, interpretation and intrinsic motivation.

7. Student Teams-Achievement Divisions(STAD)

In this model, students are grouped according to mixed ability, sex and ethnicity. The teachers present materials in the same way they always have, and then students work within their groups to make sure all of them mastered the content. This model was developed by Slavin and is called Slavin's model of cooperative learning. It was developed to tailor the differences in cognitive ability among children of the same class. This model considers students' interaction as important factor of promoting learning and derived its root from the contact theory of Allport's in Kutneck in Abdullahi, (2014).The teachers present materials in the same way they always have, and then students work within their groups to make sure all of them mastered the content. Finally, all students take individual quizzes (Zakaria & Iksan, 2007). In the same vien, Patniz (2013) opined that the scores each student contribute to their team are based upon the degree to which they have improved their individual past averages.

2.6.2 Rationale for Adopting Cooperative Learning Strategy

The quest for a better learning strategy by teachers is in the increase due to educational challenges the world over. Teachers are expected to teach in a way that enables pupils to learn science concepts (chemistry inclusive) while acquiring

process skills, positive attitudes and values and problem solving skills (Zakaria & Iksan, 2007).A variety of teaching strategies have been advocated for use in chemistry classroom, ranging from teacher-centered approach to more students-centered ones. Hence, the need for the implementation of cooperative learning strategy in learning chemistry as a science have being unveiled through several attempts in the literature.

In the vast majority of studies, forms of cooperative learning have been shown to be more effective than non-cooperative reward structures in raising the levels of variables that contribute to motivation, in raising achievement, and in producing positive social outcomes. Slavin in Abdullahi (2014) cites several studies in which students in cooperative-learning groups felt more strongly than did other students that their group mates wanted them to come to school every day and work hard in class. Probably because of such features as promoting interaction and equal opportunities for success, cooperative learning has been shown to have a positive effect on students' performance and retention. Therefore, cooperative learning is grounded in the belief that learning is most effective when students are actively involved in sharing ideas and work cooperatively to complete academic tasks. Slavin in Abdullahi (2014) opined that Students in cooperative-learning groups were more likely to attribute success to hard work and ability than to luck.

A number of instructional strategies have been successfully used to improve students' performance and retention in science particularly chemistry. Slavin cited in Abdullahi (2014) examined several studies that lasted four or more weeks and that used a variety of cooperative-learning methods. Overall, students in cooperative-learning groups scored about one-fourth of a standard deviation higher on performance tests than did students taught conventionally. This might not be

unconnected with the fact that cooperative learning advocates learner centered approach. But the beneficial effect of cooperative learning varied widely as a function of the particular method used. The best performances occurred with two techniques called Student Teams-Achievement Divisions and Teams-Games-Tournaments. Johnson, Johnson, and Smith in Abdullahi (2014) also reviewed much of the cooperative-learning literature but drew a somewhat different conclusion. They found that the test scores of students in the cooperative-learning groups were about two-thirds of a standard deviation higher than the test scores of students in competitive or individualistic situations. Given the complex nature of problem solving and the multiple resources that a cooperative group has at its disposal, one would logically expect cooperative learning to have a positive effect on this outcome as well. This hypothesis was confirmed by Johnson and Johnson in Houghton (2010). After reviewing forty-six studies, they concluded that students of all age levels (elementary, secondary, college, adult) who worked cooperatively outscored students who worked competitively. The average student in a cooperative group solved more problems correctly than 71 percent of the students who worked competitively.Henderson in Zakaria and Iksan (2007) affirmed that sensitive and controversial issues in science could be most appropriately taught when cooperative group approach is utilized. Furthermore, in the area of student's social interaction, in most studies, students exposed to cooperative learning were more likely to name a classmate from a different race, ethnic group, or social class as a friend or to label such individuals as "nice" or "smart." than students who learned under competitive or individualistic conditions (Abdullahi, 2014). In some studies, the friendships that were formed were deemed to be quite strong. A similar positive effect was found for students with mental disabilities who were mainstreamed.

On the issue of retention, studies reported that students in cooperative groups were able to master and retain information better than students in individual or competitive situations (Humphreys, Johnson, & Johnson, in Olarewaju, 2012). In the same vein, Duren and Cherrington cited in Olarewaju, (2012) observed significant improvements in long-term retention of problem solving strategies of students participating in cooperative learning groups. They reported students in cooperative groups were more willing to tackle a problem longer, made qualitative strategies and corrective feedback and attempted to use learned strategies 7% more often than independent practice classes.Johnson, Johnson, and Zaindman cited in Olarewaju (2012) hypothesized that the effects of cooperation would increase the more students worked together, encouraged and tutored each other and rehearsed materials being learned.

Properly structured cooperative learning activities are associated with positive educational outcomes (Okebukola in Olarewaju, 2012). They found that cooperative learning technique featuring intra group cooperation with inter group competition is a very effective way of improving students' achievement in science in large class situations.Cooperative-learning students were more likely to use the cooperative behaviors they were taught when they worked with new classmates than other students who learn under different learning environment (Johnson & Johnson; Slavin, in Abdullahi, 2014). This outcome should be of particular interest to Nigeria which is marked by multi-ethnic and cultural diversity.

Furthermore, the above revelations related to the justification for implementing cooperative learning in classrooms are reflections of what Slavin in Abdullahi (2014), summarized in a comprehensive review of the benefits of this instructional strategy. He drew up conclusions from forty-one studies (as reported by Olorukooba,

2001) which were experimentally controlled in classrooms. According to him, benefits derived from cooperative learning are as follows;

1. 63% of the structured groups showed an increase in academic performance as compared with those not in group;
2. inter-racial school friendships were generally reciprocated and minority group academic performance improved correspondingly;
3. cooperative learning helped overcome interactional barriers in groups including mixed ability and physically handicapped children;
4. children's self-esteem was enhanced in most of the studies;
5. cooperative groups took on norms that prompted positive school learning;
6. pupils spent more time focused on their learning tasks; and
7. children generally increased their within-classroom friendship with corresponding increases in their feelings of altruism and social perspective-taking.

Because schools are meant to socialize children to assume adult roles, and because cooperation is so much a part success in adult life, one might expect that cooperative activity would be emphasized in order to create the spirit of team work and cooperation towards goal attainment. In the same vein, Zakaria and Iksan (2007) opined that in cooperative learning,more emphasis should be given on students understanding of a particular concept, guiding students in active learning, providing opportunities for discussion and elaboration and encouraging them to work with peers and teachers. The rationale for implementing cooperative learning in the classroom may therefore be justified in terms of the benefits in the literature described above.

2.7 Laboratory method

In science education, laboratory work is considerably important because they provide the opportunity for students to perform various hands-on activities. Laboratory work is an essential part of scientific process. Scientific skills, process, knowledge and most importantly curiosity built in scientist are achieved through laboratory activities. Laboratory method is superior in teaching manual skills and in increasing understanding of the apparatus involved. Laboratory work arouse students' interest in science and also help them in proper handling of the laboratory apparatus and materials. In chemistry, laboratory skills involve things like dilution, acid base titrations and preparation of chemicals solutions, quantitative work which includes test, observation and recording of inferences (Umar, 2007). There have been many studies reporting on the effectiveness of the laboratory instruction on students' understanding of science concepts (Hart, et al 2000; Ukamaka & Okoli 2018; Özmen et al., 2009). Also, many researchers believe that laboratory work helps promote conceptual change and improves students learning. (Aktamış & Acar 2010; Igwe 2015; Özmen, Demircioğlu, & Coll, 2009) and is motivating and exciting for students (Irshad 2015; Hart et al., 2000).

According to Musa (2000) laboratory method is defined as the teaching procedure in which the learner is helped to acquire first-hand experience regarding the subject matter usually obtained from investigation or experiment. Usually equipment and printed laboratory manuals are given to the students in order to carry out an investigation under the guidance of the teacher. In Nigerian situation, it's mostly carried out in groups depending on the availability of the materials and the class size. In the same vein, laboratory method is a situation where by students are engaged in significant experiences with experimental processes, including some experience, observation and investigation (Ojediran, Oludipe, & Ehindero,

2014).The laboratory work should therefore help the students develop a broad array of basic skills and tools of experimental chemistry like volumetric analysis and data analysis as well.

Laboratory approach to teaching is a situation in which students are guided to find out the truth about ideas, facts or assumptions for ultimate confirmation or rejection. Under this arrangement, students are provided opportunity with materials within the environment through observing, classifying, measuring, questioning, hypothesizing, collecting and interpreting data, accurate reporting, predicting and inferring.

However, teachers need to organize their learning environment and fallow the appropriate steps while working with laboratory method. Chiapetta cited in Goje (2014) opined that there are three steps that every teacher needs to fallow when using laboratory method. These are:

i Pre –laboratory discussion: These involve preparations which make students ready for laboratory activity. Here the teacher discusses the important point concerning the laboratory activities to be carried out.

ii Given directives: Directions for laboratory exercises must be explain clearly by the teacher. They can be given orally or in written or mentioned during pre – laboratory discussions.

iii Post –laboratory discussion: This step is an excellent time to broaden students understanding of the content and processes of science. To ensure success in the laboratory method, laboratory work need to be organized and carefully planned in order to guide students to achieve the desired outcomes. Great consideration should be attached to the relevance of the laboratory work, the degree of steps involved in the activities and the method by which students will record and report their findings.

In related development, Risk in Umar (2007) stressed that the steps involved in laboratory method are as follows:

a. Introduction: This involve the presentation of the apparatus and dilution of the materials to be used in the experiments by the teacher and the laboratory technician and the conducting of practical work by the teacher prior to the commencement of the experiment by the students. Preparation of the laboratory takes more time than the actual experiments.

b. Work period: In this step, students are engaged in the experimental activities individually or collectively to solve the problem in question. Students are involved in experimenting, observing, and searching for an answer and the teacher is directing them to make sure that they reach the desired goal.

c. Culminating activities: This is the period for discussing their findings and the experiences gain during the activities. The teacher should be able to assess what knowledge, change of attitude or academic skills students have gained as a result of their exposure to laboratory method.

Looking at the above steps, we can notice that laboratory – based strategy involves well organized procedures which encourage students to learn scientific concepts by themselves. Hence, the strategy advocates student centred approach which is in line with the new trend of teaching and learning of chemistry as a science subject.

Laboratory method can offer a unique learning environment which can help students to construct their knowledge and develop logical and inquiry-type skills (Abdullah, Mohamed & Ismail, 2009). It can also promote positive attitudes, provide students with opportunity to develop skills regarding cooperation and communication, and stimulate the students and allow them to be creative, which are compatible with the

constructivist teaching models (Faire & CosgroveinÖzmen, Demircioğlu, Burhan, Naseriazar, 2012; Hofstein, 2017).

In the same vein, laboratory method takes place in a learning environment called the laboratory which differs from a classroom. Fraser cited in Umar (2007), affirmed that laboratory is seen as an integral part of most science courses and offers students a learning environment that differs in many ways from the traditional classroom setting. According to Abdulkadir in Umar (2008) laboratory is a room building or classroom which is equipped with apparatus and materials for conducting scientific and technical experiment, investigation, test and scientific researches. Therefore, laboratory is an environment which is entirely different from conventional classroom where all the school subjects can be taught.

Practical work or experiments usually takes place in the laboratory. Laboratory work as an active learning method, which require students to involve in observing or manipulating real objects and materials, have a distinctive and central role for development of students' understanding of scientific concepts, improving cognitive skills as well as developing positive attitudes (Brown, Collins, and Duguid in Tarhana& Sesen, 2010; Hofstein & Lunetta, 2004).This study is based on constructivist theory which support that instruction using laboratory process can encourage hands on activity in science particularly learning chemistry concepts like acid and bases. Tarhan and Sesen (2010) opined that instruction supported with laboratory experiments based on constructivism increase students' learning achievement in the learning of *'Acid and Bases'*, and positively affect students' attitudes towards chemistry laboratory.

Laboratory work is one of the most important aspect of science which differentiate it from other subjects in secondary schools. Standard chemistry laboratory on the

other, give students a unique learning environment equipped with materials and apparatus for learning chemistry. Among the important aspect of practical work which covers about 60% of secondary school practical chemistry is volumetric analysis. It is defined as the quantitative analysis of unknown chemical solution by determining the amount of reagent of known concentration necessary to effect a reaction in a known volume of a solution (Webster new world college in Goje, 2014). Volumetric analysis is a widely-used quantitative analytical method. As the name implies, this method involves the measurement of volume of a solution of known concentration which is used to determine the concentration of the analyte (Wired Chemist, 2017). Volumetric analysis refers to any method of quantitative chemical analysis in which the amount of a substance is determined by measuring the volume that it occupies. In this regard, the volume and concentration of one solution is known and a titration method is used to find the exact volume of the second solution necessary to react completely with the first. The concentration of the second solution can then be determined if the equation of the reaction is known (Goje, 2014). The commonest volumetric analysis in secondary chemistry is the acid and base titration. Titration is a laboratory method used to determine the unknown concentration of a reactant. This is a delicate procedure that requires patience and good observation skills (ChemEd, 2017). Usually, an indicator is used in titration to determine the endpoint of the reaction. Once the endpoint volume is found, mathematics can be used to determine the concentration of the unknown.

Volumetric analysis as opposed to qualitative analysis is always dealing with the concentration of a solution. According to Osagbemi in Goje (2014), the principles of volumetric analysis can be summarized as follows:

e. In the titration flask is placed a measured volume of one solution (titrand) while in the burette is placed the other solution titrant.

f. The titrant is being gradually added to the titrand (which contains a definite amount of base) until enough quantity of the titrant has been added to react completely. This is referred to as neutral or end point.

g. The end point is detected by means of an indicator.

In this regard, the volume of the titrant required to react with (or neutralize) a given volume of titrand is noted. Knowing the volume of the titrant allows the student to determine the concentration of the unknown substances (Nelson & Kemp cited in Goje, 2014). The whole process is referred to as titration which its history can be traced back to the origins of volumetric analysis, which began in the late eighteenth century in France (ChemEd, 2017). Therefore, volumetric analysis has a greater history which relates to the field of analytical chemistry.

Based on this premise, laboratory method is one of the learning strategy which advocates learner centred approach. As such, this research work intends to adopt laboratory method in teaching the concept of acid and base to secondary students. The model is chosen because of its unique characteristics of providing the optimum opportunities for the students to develop scientific skills and processes which in turn improve performance in sciences. The model makes the students to become familiar with the laboratory work and the laboratory as a learning environment.

2.7.1 Rationale for Adopting Laboratory Method

One of the most important aspects of science education is hands –on activities which give students the feeling of being scientist and the ability to develop scientific skills and processes. Students should develop an ability to investigate and verify scientific information. They must be required to communicate scientific ideas as part of their

academic experience. These are part of secondary school chemistry curriculum that will help students develop curiosity about relevant scientific issues. The curriculum will also instill a desire to further investigate the wonders of science (ACS, 2012). These scientific processes can be achieved using laboratory method as a learning model.

Laboratory method stimulates the acquisition of both manipulative and cognitive skills by learners (Hofstein, 2017). Studies have been critically and extensively reviewed by scientist like Blooser, Hoftstein and Lunetta cited in (Goje, 2014). They opined that history and research finding proved that laboratory has been regarded as a medium of instruction in secondary school science teaching and learning over the years. Later, Tobin in Goje (2014) prepared a follow up synthesis of research on the effectiveness of teaching and learning in the science laboratory. He suggested that meaningful learning is possible in the laboratory if students are given opportunities to manipulate materials and apparatus in a suitable environment to construct their knowledge of phenomena and related scientific concepts. This will help the students to perform greatly and be able to retain basic scientific concepts.

In related development, Hodson (2005) collected information about the priorities that Ontario institute for studies in education (university of Toronto) have for practical work revealed the five top ranking reasons cited by secondary school teachers and these include;

a. To assist concept acquisition and development
b. To motivate by stimulating interest and enjoyment
c. To teach laboratory skills
d. To give insight into scientific method and to develop expertise in using it

e. To develop certain scientific attitudes such as curiosity, open-mindedness, objectivity and willingness to suspend judgement.

The need for the implementation of laboratory Method in the science, most especially chemistry become imperative due to the fact that this model encourages hands –on activities. The strategy involves students working individually or in groups, while interacting with materials to learn scientific skills and concepts.

In the same vein, Hofstein and Lunetta (2004) conducted another analytical review of the literature and concluded that teachers should understand what students in the laboratory, how they learn and the appropriate method of assessment. They stressed that science teachers should develop strategies, protocols and resources for teaching in the laboratory. If these are taken care of, it will help in engaging students in inquiry and practical skills in learning of chemistry. This will eventually enhance development of knowledge and the ability to retain basic concepts of chemistry.

Effective science teaching demands that students are given the opportunity to interact with material and control their learning environment. Piaget (cited in Mari, 2001) opined that intelligence develops not by virtue of operation alone, but also as a result of interaction of the learner with his learning environment. Laboratory method allows student to use materials and constantly interact with their learning environment.

However, the teaching and learning of chemistry as a physical science is shifting over the years from the traditional method to the modern trend of student centred approach. Therefore, laboratory method is one of the student centred approach employed in teaching chemistry. It is a practical as well as activity based strategy to learning of chemistry, and the method is learner centred friendly. Appropriate laboratory activities can be effective in supporting learners construct their

knowledge, develop logical skills as well as problem solving abilities. SCORE (2018) opined that the importance of practical work in science is widely accepted and it is acknowledged that good quality practical work promotes the engagement and interest of students as well as developing a range of skills, science knowledge and conceptual understanding. In the same vein, practical work also helps develop in the students' the psychomotor skills as it encourages hands on activity.

The laboratory-based mode of presentation of concepts has been consistently found to be an important strategy in Chemistry teaching and learning in secondary schools (Amba & Chinwendu, 2015). It is important to note that at secondary school level, the teaching and learning of chemistry form the foundation of chemistry as a science subject. Therefore, it is important for student to be part of the laboratory work in order to develop interest in science. Laboratory Method is closely to cooperative strategy, in the sense that both are activity oriented. Gunstone, in Goje (2014) opined that for practical activities to have any significant effect on student performance, theory reconstruction and linking of concepts should take place in different ways to make sure that students spend more time interacting with ideas and less time interacting with apparatus. This implies that in laboratory work, the emphasis should not be on the use of the laboratory equipment but rather how students use them to achieve their goals, in the form of interacting together to solve problems with the support from the teacher.

2.8 Traditional Teaching Method (Lecture method)

Teaching method is as old as teaching itself. Time immemorial, man tried to impart knowledge in the best way he thinks best suit the system. Russon and Winous cited in Umar and Gumel (2008) stated that there are only two methods of teaching; the authoritative and the developmental. The former involves teacher talking or writing

on the chalk board while the later guide the students and encourage them to do things by themselves. In authoritative (talk-talk method), the teacher usually dominates the class, hence authority is pronounced where in the developmental (activity-based), learners are encouraged to work by themselves, therefore, learner-centered approach is supported. The authoritative is regarded as the traditional or lecture method. Knowledge is best imparted in the learner through teaching. However, there are quite a number of approaches through which teaching is carried out. Teach (2016) opined that teaching theories primarily fall into two categories or approaches; teacher-centered and student-centered. In the former, students are viewed as "empty vessels" whose primary role is to passively receive information (via lectures and direct instruction) with an end goal of testing and assessment. It is the primary role of teachers to pass knowledge and information onto their students.

In the same vein, approaches to teaching are however related to theoretical assumptions and philosophical viewpoints (Galadima, Nura & Yusif, 2008). They therefore classified teaching approaches into three main categories:

1. Teacher-centred approach
2. Child-centred approach
3. Mid-way approach

Teacher-centred approach is the approach of the philosophical school of idealism emphasized by people like Plato. It places a great importance on the position of the teacher who act as the guardian of all that is best in man's vast heritage. The teacher is regarded as all-in-all, as a think tank process whereas the student is regarded as "tabular-rasa" (Galadima, Nura & Yusif, 2008).

Lecture method is predominately used in our educational institution (Aina, 2009). The lecture method is a traditional method of transmission of knowledge to learners

characterized as one – way flow of information from the teacher who is always active to the learner who is always passive (Sola & Ojo, 2007). The method is the most frequently used method of instruction (Suleiman, 2010). Obeka (2009) define lecture method as a talk-chalk method of teaching in which the teacher does most of the talk while the students listen and take down notes. Atadoga and Onaolopo (2008) also described the method as a didactic approach, defining it as a teaching technique in which one person usually the teacher presents a spoken discourse on a particular subject. Adesoji (2008) opined that eighty percent (80%) of scientific information or principles are passed on to students through lecture method. He stressed that many academicians have accepted lecture method as a proper way of importing knowledge since our educational system puts so much premium on external examinations. Lecture method helps a science teacher covers a large amount of material (syllabus) to a large class size in a very short period. This is however detriment to students' learning, but the teacher may not have a choice being driven by the pressure to cover the syllabus and prepare the students for the external examination which is the only qualifying measure to the next level or employment. This is the most common reason why teachers use lecture method in our secondary schools, and the method does not involve students for cooperation and laboratory activities.

However, lecture method is characterized by one flow of information from the teacher to the learner whereby the teacher is the authority. It is traditionally referred to a didactic approach and has been defined as a teaching technique in which one person, usually the teacher, a spoken discourse on a particular subject (Aminu, 2010). It is assumed that the teacher has all the knowledge of the chemistry concepts, and he does all the talking and students do all the listening.It emphasizes "chalk and talk" in the teaching of chemistry and indeed an oral presentation

intended to present information or teach people about a particular subject and are used to convey critical information historical background theories and equations (Donald, in Shehu 2016). Related to this, Mallick (2012) stressed that when teaching sciences using lecture method,it is the teachers who provide information of various scientific concepts and principles whereas students remain as passive listeners can try to understand the information imparted by the teacher. The chemistry teacher in this regard, view his students as empty vessel waiting to have science knowledge. Lecture method of teaching emphasizes "Talk and chalk" in the teaching of science subjects more than eighty percent 80% of scientific information and principles are delivered as lecture (Bichi 2001). The learners have no or little room for any contribution, they ask no or very few questions. A traditional science classroom is always silence with only the teacher talking, writing or dictating notes.

In a related development, the Education Sector Support Program in Nigeria (ESSPIN) conducted a baseline survey on the teaching and learning in 6 States, namely Enugu, Jigawa, Kano, Kaduna, Kwara and Lagos, to determine what teachers and children do in the classroom. Lessons were observed and, every 4 minutes, the behaviors of the teachers and children were recorded. The summary of the report (ESSPIN report in Davison, 2009) is as follows:

In an average lesson (30 minutes), the teacher spends:

18 minutes either working on the blackboard, watching a student working on the blackboard, or watching the class from near the blackboard.

1 minute using teaching materials of any kind

3 ½ minutes moving around the class watching children

1 ½ minutes talking with individuals, groups or pairs, mostly from the front of the classroom.

4 minutes doing nothing at all.

In an average lesson, (30 minutes), the children spend:

18 minutes in silence (of this, 14 minutes is listening to the teacher or child working on the blackboard).

About **12 minutes** saying something in their own word orally or in writing.

The above information shows that most of the activities are teacher-centered,listening to the teacher, chanting and repeating answers as a whole class. The teacher spends very little time working with groups and individuals. Little use is made of materials. Children are not encouraged to think or express themselves in their own words, in other words, lecture method predominates. It means that in lecture method students is not given any chance for cooperative and laboratory method which allows the spirit of students working together, helping each other and encourage activities among the students.

2.9 Basic Concepts in Chemistry

The Basic concepts of chemistry according to national chemistry curriculum falls under themes like that of the chemical world, chemistry and environment, chemistry and industry and so forth. These concepts keep on re-occurring at the various level of learning chemistry at the senior secondary schools. Under the theme “chemistry and the environment”, concepts like that of standard separation techniques for mixtures, acid, bases and salts and their reactions, water, air, and so forth are among the concepts of chemistry contained in the curriculum. The chemistry concept used in this study is that of acid and base.

Concepts of chemistry which are related to learning achievement, are also important outcomes of science education (Cheung, 2009). For this reason, this study is aimed at investigating the effects of cooperative and laboratory method on the performance

and retention of students in chemistry in Jigawa state, which is based on constructivism related to acids and bases.

2.9.1 Acid and Base Concept of Chemistry

Scientists the world over have tried to explain the concept of acid and base using different approaches. Among the popular ones are that of Arrhenius and Bronsted-Lowry Theory of acids and bases.

The Arrhenius definition of acid and base state that, acids are substances which produce hydrogen ions in solution while bases are substances which produce hydroxide ions in solution. Bronsted-Lowry theory defined acid as a proton (hydrogen ion) donor, and base is a proton (hydrogen ion) acceptor.

However,Bronsted-Lowry theory does not go against the Arrhenius theory in any way - it just adds to it. Hydroxide ions are still bases because they accept hydrogen ions from acids and form water.

An acid produces hydrogen ions in solution because it reacts with the water molecules by giving a proton to them. Lewis on the other hand, define acid as an electron acceptor for the formation of a compound or a complex ion, while a base is an electron donor for the formation of a compound or complex ion (Clark, 2013).Acids and bases are characterized as strong or weak. A strong acid or strong base completely dissociates into its ions in water. If the compound does not completely dissociate, it's a weak acid or base. How corrosive an acid or a base is does not relate to its strength.

Examples of some common acids includehydrochloric acid (HCl), Trioxonitrate (v) acid (HNO_3), Tetraoxosulphate (vi) acid (H_2SO_4). Acids show properties like sour test, they give off hydrogen gas when they react with active metals and they liberate carbon dioxide from trioxocarbonate (iv) salts. The strength of the acid depends

upon the concentration of ionized hydrogens and strong acids are completely ionized in water e.g. hydrochloric acid, while weak acid is only slightly ionized and produce a low concentration of hydroxonium ions such as organic acids like ethanoic acid. This should not be confusing with the concentration of acids. The differences in concentration of the entire acid is termed as dilute or concentrated. Acids are very important chemicals which we use in our everyday lives. They are use in industries to make other consumer chemicals such as fertilizer, detergents and drugs. They are use in industries as drying agents, oxidizing agents and as catalyst.Without acids, we won't have Vitamin C (ascorbic acid), your car won't start (sulphuric acid in car batteries) or even accelerated rotting of your food that is, food preservative in the form of citric acid (Berry Berry Easy-BBE, 2012).

A base is a metallic oxide or hydroxide which can neutralize an acid to form salt and water only. Most oxides and hydroxides of metals are bases. Some common examples are sodium hydroxides, potassium hydroxide and magnesium hydroxide. They are form when these metals burn in air or oxygen.Bases have many practical uses, and several of them are commonly found in the home. Household ammonia is a familiar cleaning agent. Lye is used for cleaning clogs and sink drains. Potassium hydroxide, also called caustic potash, is used to make soft soap that dissolves in water with ease. Magnesium hydroxide in water (also called milk of magnesia) is used as an antacid or laxative.

Bases can be thought of as the chemical opposite of acids. A reaction between an acid and base is called neutralization. Bases and acids are seen as opposites because the effect of an acid is to increase the hydronium ion ($H3O^{+}$) concentration in water, whereas bases reduce this concentration. Bases react with acids to produce salts and water.

A salts positive ion comes from the base and its negative ion comes from the acid. Considering a metal hydroxide as a base the general reaction is:

$HX_{(aq)} + MOH_{(aq)} \rightarrow MX_{(aq)} + HOH_{(l)}$

acid base salt water

A strong acid HCl (hydrochloric acid) reacts with a strong base NaOH (sodium hydroxide) to form NaCl (salt = sodium chloride) and water. If the amounts of the acid and the base are in the correct stoichiometric ratio, then the reaction will undergo complete neutralization where the acid and the base both will lose their respective properties.

$HCL_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$

strong acid strong base salt water

A strong base NaOH (sodium hydroxide) added to a weak acid CH_3COOH (acetic acid) in 1L of solution, forming $NaCH_3COO$ (sodium acetate) and water.

$CH_3COOH_{(aq)} + NaOH_{(aq)} \rightarrow NaCH_3COO_{(aq)} + H_2O_{(l)}$

weak acid weak base salt water

Weak bases react with strong acids to form acidic salt solutions. The conjugate acid of the weak base determines its pH. For example, NH_3 (ammonia) is added to HCl (hydrochloric acid) to form NH_4Cl (ammonium chloride).

$NH_{3(aq)} + HCl_{(aq)} \rightarrow NH_4Cl_{(aq)}$

weak base strong acid salt

As soon as the salt is formed it reacts with water, resulting in a slightly acidic solution.

Salt solutions containing acidic cations and basic anions such as NH_4F (ammonium fluoride) have two possible reactions:

$NH_{4+(aq)} + H_2O_{(l)} \leftrightarrow H_3O^+(aq) + NH_{3(aq)}$ $K_a(NH_4^+) = 5.6 \times 10\text{-}10$

$F_{-(aq)} + H_2O_{(l)} \leftrightarrow HF_{(aq)} + OH_{-(aq)}$ $K_b(F^-) = 1.4 \times 10\text{-}11$

Since $K_a(NH_4^+) > K_b\ (F^-)$, the reaction of ammonia with water is more favorable. Therefore, the resulting solution is slightly acidic.

However, stoichiometry is a term used to describe calculation involving the mass relationship between atoms in a compound and between molecules and atoms participating in chemical reactions. It means that the mole ratio in which reactants combine and products are formed gives the stoichiometry of the reaction. Since hydrogen is the lightest atom with the relative atomic mass of one (1), therefore in one gram of hydrogen atom, we have one mole of atom, carbon with relative mass of 12g has one mole of carbon. Since one mole represents molar mass of a substance in grams, we can also evaluate the reacting mass relationships between reactant and products from a balanced equation.

For students to understand the principles of titration, a thorough knowledge of balancing an equation, mole concepts and molar concentration terms are required. When the concept of molar concentration is applied to the solution of acid and base, the exact amount of the acid or the base present in a given solution can be determined. The method of determination is called titration.In a titration, a solution of unknown concentration is reacted with a solution of a known concentration in order to find out more about the unknown solution (Chemcool, 2017). In an acid-base titration one of the solutions is an acid and the other a base.

One is placed in a flask. The other is placed in a burette, from which it is dripped into the flask until the titration reaches its end point.

A suitable indicator needs to be chosen such that the end point shows accurately that all of the solution in the flask has reacted with the solution being dripped into it - the

point at which this happens is called the equivalence point, end point or the neutralization point. The final burette reading is then taken. At the end point the amount in moles of the acid and the base are exactly in the same ratio as required in the balance equation of the reaction.

The common volumetric analysis in secondary schools is the titration which involve acid and base reactions. Titrations are carried out in secondary schools in order to assess a chemistry students on practical aptitudes. It is a mandatory unit for senior secondary chemistry examinations and even observable at undergraduate level chemistry. However, secondary school and college students knowledge of science concept is often characterized by lack of coherence and the majority of students engage in essentially rote learning. This situation therefore calls for alternative teaching strategies and the choice of the topic "acid-base concepts" in the present study. This study is going to investigate the effects of cooperative and laboratory method on performance and retention of students in chemistry in Jigawa state Nigeria.

2.9.2 Retention of Concepts in Chemistry

Scientific concepts seem to be unfamiliar to many students in secondary schools. Chemistry as a physical science has many concepts which looks new to many students, hence retention ability become an issue before them. A common complaint among science and mathematics teachers is that students do not know, remember or have sufficient mastery of materials they have previously been taught (Yobo, 2011). Therefore, a better learning strategy need to be considered by teachers in order to improve students' retention ability.

Retention is the ability of the learners to recall information, ideas or learning activities at a later time. Bichi, (2001) defined retention as the ability to maintain

and later recall information or knowledge gained after learning. However, many researchers have also investigated and defined several variables that affect knowledge retention. Obeka (2009) states that they include the type and content of tasks to be learned, amount of original learning, instructional strategy used and length of retention interval. Olarewaju (2012), described retention is the ability to store information which can be easily recalled from the short and long term memory. In related development, retention is the ability to retain and consequently remember things experienced or learned by an individual at a time. It takes when learning is coded into memory. Thus, appropriate coding of incoming information provides the index that may be consulted so that retention takes place without an elaborate search in the memory lane (Bichi, 2001). The nature of the material to be coded contributed to the level of retention. Materials are related to the quality of retention in terms of their meaningfulness, familiarity, concreteness and image evolving characteristics (Okereke, 2006). Several factors are known to influence retention. (Bichi, 2001) reports that learning should improve retention while things that lead to confusion or interference among learned materials decrease the speed and efficiency of learning and accelerates forgetting.

The students therefore are able to learn more of what is taught and retain it longer than when the same content is presented in other instructional formats like cooperative and laboratory method. Hence, chemistry concepts like acid and base need to be presented to the learners in a way or through a method that touches learners sub consciousness which can activate quick recalling of the concepts being taught or learnt. Students would be able to use cooperative and laboratory method in terms of understanding, explaining and retaining the acid and base concepts they have learnt in chemistry class. There is an old concept in science education which

supports the idea that most students need hand on laboratory experience to learn concepts. It is based on the cognitive levels of development originally put forward by Piaget which is in line with the constructivist theory and supported by Chinese proverb " I hear and forget, I see and remember, I do and I understand" (Vaillancourt, 2009). Therefore, hands on activity is an important aspect of cognition in teaching and learning.

A number of studies which had replayed the role of teaching methods used in delivering instructions to retention ability as well as academic performance are reviewed in this section. According to Chauhan (2007), retention is the ability of an individual to remember things. Permanent and meaningful learning are ultimate target of educational endeavour (Chauhan, 2007). Understanding and retention are products of meaningful learning when teaching is effective and meaningful to the students (Bichi, 2001). In a study which included retention treatments, Ikedolapo and Adetunji (2009) compared the relative effectiveness of the guided discovery and concept mapping teaching strategies in retention to students' performance in Chemistry. A t- test statistic was used to analyse the data obtained and the results indicated that there was no significant difference in the mean scores of the students due to post posttest (retention) treatments. It was also observed that gender made no significant difference when the mean scores of the methods adopted were compared on the post posttest (retention) treatment. In this study, the students' retention ability toward learning the concepts of acid and base is going to be investigated using cooperative and laboratory method.

2.10 Students' Academic Performance in Chemistry

It is evident that poor academic performance of secondary school students affects science subjects, chemistry inclusive. A number of instructional strategies have been

successfully used to improve students' performance in science in Nigerian secondary schools over the years. In this regard, many scholars have identified several instructional strategies in teaching chemistry. Bruner, Gaagne, and bloom cited in Aina (2009) have supported the use of several teaching strategies among which includes problem solving, guided approach, cooperative, inquiry, demonstration, guided discovery and project laboratory. The major challenge facing teachers as the key players in meeting the students' needs in the classroom is how to effectively teach the students in order to improve their academic performance. The search for a better and effective instructional strategy has been a major concern by many researchers and teachers in the recent past. This research work therefore takes into cognizance the effects of cooperative and laboratory method towards improving students' academic performance in secondary schools.

2.10.1 Cooperative Instructional strategy and Performance

Cooperative learning is an approach to group work that minimizes the occurrence of unpleasant situations and maximizes the learning and satisfaction that result from working together as a team. Johnson and Johnson in Abdullahi, (2014) reported that cooperative learning results in a greater effort for achievement, more positive interpersonal relationships and greater psychological health than competitive or individualistic learning efforts. Academic performance of students has been found to be enhanced by the use of cooperative learning. Parveen, Yousuf, and Mustafa (2017); Gull and Shehzad (2015); Ebrahim (2012) and Altun (2015); reported that cooperative learning has been linked to enhancing the academic performance of learners at all ability levels. Therefore, cooperative learning strategy is a relevant teaching strategy for improving students' cognitive abilities.

In the same vein, Mcclintock and Sonquist inOlarewaju (2012) studied undergraduate college sociology students and found students participating in cooperative groups received higher than average grades on term papers than working individually. They also concluded that group's performance was often better than what could have been expected of the best student in the group. In the studies of Pandey and Kishore (2017)Cooperative learning was found to help students interact with each other, generate alternative ideas and make inferences through discussion. Therefore, cooperative learning strategies were found to improve student performancein science classes.

In order for concepts like that of acid and base in chemistry to be properly learnt and understood, the methods used in teaching the concepts play a vital role and various reasons had been advanced in attempts to rationalize low performance to science subject among students. According toUK Essays (2015)poor teaching methods have

highly affected our mind and our thinking making us feel that we are not good at certain subjects, even making us go as far as hating the subject, whereas all that is required is a different approach. Therefore, poor performance in chemistry attests to the fact that science teaching has not been properly done, or wrong approach has been adopted. For science teaching (chemistry) to be properly conveyed, there is need for the choice of the appropriate instructional strategy/method, which will in turn aid performance. Base on this premise, this study considered the effect of cooperative instructional strategy on performance of secondary school students.

2.10.2 Laboratory method and Performance

Laboratory method encourages students to interact with learning materials under the guidance of the teacher. This situation helps the students to have greater performance and retention of chemistry concepts like that of acid and base. The laboratory-based mode of presentation of concepts has been consistently found to be an important strategy in Chemistry teaching and learning in secondary schools (Amba & Chinwendu, 2015). This might not to be unconnected to the fact that laboratory method is usually hands on activity which improve knowledge and retention ability of students.

Laboratory method make students more active in their learning. The literature suggests that students enjoy laboratory work because it is more active (Hart et al., 2000). In the laboratory, students have a chance to engage in hands-on activities, and both science and non-science majors are reported to find laboratory-based activities to be motivating and exciting (Irshad, 2015). Despite some reservations, many authors believe that laboratory work helps promote conceptual understanding (Hart et al., 2000; Özmen, Demircioğlu & Coll, 2009). Besides, practical works in laboratory gives students opportunity to gain some psychomotor skills through

scientific investigations and hands-on activities and has the potential to significantly enhance performance and development of conceptual understanding (Abdullah, Mohamed & Ismail, 2009). Therefore, laboratory method can improve performance and retention ability in chemistry.

Drill and practice can be applied to train students to pass practical examination through the use of alternative instructional method like laboratory method. This means that students' performance can be improved by the use of laboratory method. Hofstein and Lunetta (2004) suggest that laboratory activity has a potential to enhance constructive social relationship as well as positive attitude and cognitive growth. In the same vein, Okebukola in Goje (2014) summarized his study claiming that a greater degree of participation in the science laboratory resulted in an improved performance towards chemistry learning in general and towards in chemistry laboratory in particular. Laboratory method encourage students working with apparatus and materials in laboratory environment. This gives room for developing scientific skills and processes which in turn improve performance and retention ability of chemistry concepts.

2.11 Empirical Studies

This study is titled "effect of cooperative and laboratory method on performance and retention of students in chemistry in secondary schools in Jigawa state, Nigeria". Various researches have been conducted in this country and the world over which are directly or indirectly related to this study.This section therefore aims at highlighting salient features of some related empirical studies whose findings have relevance to this study.

A research conducted by Isah (2015) investigated the impact of cooperative leaning strategy on performance and retention in geometry among junior secondary school

students in Sokoto state, Nigeria. The purpose was to investigate whether or not CLS enhances the performance and retention ability of students in geometry construction of JS III as against the use of CLM. The design of the study was quasi experimental control group design such as: pre-test, post-test and post post-test design. Junior secondary students formed the population of the study. The study area consisted of 34 public coeducational junior secondary schools in Sokoto State, which together sums up to a total of ten thousand one hundred and three (10,103) JSS III students. The average age of the population was 15 years. Six thousand and twelve (6012) male and four thousand and ninety-one (4091) were female which all together sums up to ten thousand one hundred and three (10,103) JSS III students. Out of 34 schools in the population, two schools were purposively selected. Purposive sampling technique was used here to enable the researcher to reach the targeted sample quickly.

In the same vein, the instrument used for data collection was Geometry Construction Performance Test (GCPT). GCPT is a 30 items multiple choice objective test with four options (A, B, C and D). The reliability coefficient of the instrument used was 0.63. Four research questions were asked from which four null hypotheses were developed and tested at 0.05 level of confidence. Independent t-Test was used to analyze each hypothesis appropriately. The analysis of the data indicated that students taught with cooperative learning strategy performed and retained significantly higher than students taught with conventional lecture method. The study therefore, recommended that CLS should be adopted in the teaching and learning of mathematics in general and geometry construction in particular.

The above study has a significant relation with the present study in that it sought to find out the impact of cooperative leaning strategy on performance and retention

among students. Like the present study, the design of the study was quasi experimental control group design of pretest, posttest and post posttest design. In contrary, the above study has four hypotheses which were analyzed using t-test while the present study formulated six hypotheses which were analyzed using t-test and ANOVA. In addition to this, the above study was in mathematics and in junior secondary schools in Sokoto state whereas the present study was in chemistry in senior secondary schools in Jigawa state.

In a related study by Alake (2015) the efficacy of laboratory method on students' geometry performance, retention and attitude among junior secondary schools, of Kaduna state, Nigeria was investigated. The objectives of the study among others includes to assess the efficacy of laboratory method on performance of students' in geometry at junior secondary schools and to determine the performance of male and female students taught geometry with laboratory method. A sample of N=290 students were drawn from 5,483 randomly selected from the secondary schools in Zaria Educational Zone. The subjects were divided into two groups, the experimental group N=150 and the control group N=140. The study adopted the pre-test, post-test, post post-test experimental and control group design. Two instruments were developed and validated for data collection. They are (i) geometry Achievement Test (GAT), and (ii) attitude towards geometry inventory (ATGI) five null hypotheses were tested. The data generated from the pilot study was used to determine the reliability coefficients of the test instruments which was found to be 0.76. The data collected were subjected to statistical analysis. The t-test for independent sample statistic was used to test for the hypotheses on performance. The t-test for independent sample statistic was used to test for the hypotheses on performance. Mann-Whitney u-test tool of least significant difference was used to

test the attitude of the subjects to the laboratory method. The major findings from the study were that; (i) students exposed to laboratory method achieved, retained the learnt concept and developed more positive attitude to geometry than their counterpart exposed to conventional method of teaching (ii) The laboratory method was suitable for both male and female students in teaching and learning of mathematics. On the basis of these findings, recommendation was made some of these are as follows: mathematics teachers should be encouraged to use mathematics laboratory method by providing all the materials needed for effective implementation. Students' attitude towards mathematics should be positively changed by involving them to participate actively in the learning process.

The study above was similar to the present study in the sense that they both investigate the effect of laboratory method on students' performance and retention. Both study adopted quasi –experimental design of pretest, posttest and post posttest structure. The t-test for independent sample statistic was used to analyze hypotheses on performance and retention in both studies. However, the two studies are different because the above study consider only laboratory method in mathematics among junior secondary schools in Kaduna state while the present study considered both cooperative and laboratory method on performance and retention in chemistry among senior secondary schools in Jigawa state. The above study used t-test to analyze hypotheses while the present study considered both t-test and ANOVA to analyze the hypotheses.

Tunga (2015) conducted a research on the effects of cooperative learning as an instructional strategy for teaching Quantitative Chemistry. The study also investigated how other variables like sex affect students' performance in quantitative chemistry when cooperative learning was used as an instructional strategy. In the

study, three hypotheses were formulated and tested at 0.05 level of significance. The study employed a pre-test- post-test quasi-experimental design, with the population of 980 SS II chemistry students in Kebbi state, from where a sample of 200 students was purposively selected. The instruments used for the collection of data were Cooperative learning guide (CLG) and Achievement test in quantitative chemistry (ATQC). All the data collected were analyzed using t- test statistics. The major findings of the study were: the students in cooperative learning group performed higher than those in traditional classroom learning group; there is also an insignificant difference in performance between the male and female students in the cooperative learning group. Based on the findings, it was recommended that cooperative learning strategy should be adopted by all secondary school chemistry teachers as an effective learning strategy in order to improve students' performance.

The above study was related to the present study in the sense that both studies used quasi-experimental design, SS II as population of the research and t-test statistics for data analysis. Also both studies are related because they attempt to find out the effects of cooperative strategy on performance of secondary students. However, unlike the above study which was carried out in Kebbi state, the present study was carried out in Jigawa state. The present study, in addition to cooperative strategy, also considered laboratory method as a variable in the study. The present study has six hypotheses to be tested and in addition to t-test, some of the hypotheses were tested using ANOVA.

Study conducted by Okigbo and Osuafor (2008) investigated the effect of using mathematics laboratory in teaching on students‟ achievement in junior secondary school mathematics. The study was a quasi-experimental research in which a total of

100 JS3 mathematics student were involved. From the findings, it was observed that; the use of mathematics laboratory enhanced achievement in mathematics.

The above study was similar to the present study in that they both investigate the effect of laboratory on students' performance, and both studies used quasi-experimental research design. The present study was different from the above study because the present study considered the use of another variable (cooperative strategy) and it also tested both performance and retention.

In the study of Musa (2000), the relative efficiency of laboratory teaching method for enhancing the academic performance of chemistry among senior secondary school students in sabon gari local government, Kaduna state was investigated. The main purpose of the study was to find out the effect of laboratory as a teaching method on the academic performance of chemistry students. The sample composed of 75 senior secondary II chemistry students randomly drawn from two schools. The research design was quasi –experimental design. The instrument used was tagged chemistry achievement test which has 40 items option multiple choice and data collected were analyzed using t-test statistics. The result indicated that the experimental groups performed better in chemistry than the control group. The findings support that laboratory method is a better strategy for improving students' performance in chemistry.

The above study was similar to the present study because they are both trying to investigate the effects of laboratory method on students' performance in chemistry. Both studies used SS II secondary students as population of the studies and t-test statistics were used in analyzing the data. But the two studies were different because the former used 40 items multiple choice and the latter is going to use 50 items multiple choice as instrument for data collection.

In the same vein, a study was carried out by Ogundiwin, Asaaju, Adegoke and Ojo (2015) on the effect of Group Investigative Laboratory method, on students' achievement in Biology. The purpose of the study was to explore the extent to which the moderating effect of students' gender differences in the students' academic achievement in Biology. The study adopted a pretest, posttest, control group, quasi-experimental research design. 157 senior secondary school students participated, with nine intact classes from nine schools from three local government Area of Oyo state. Two research Hypothesis was tested at 0.05 Alpha level, five instruments used in the study were: Four instruments used for this study and they were; Biology Achievement Test (BAT), Teachers' Instructional Guide on Group Investigative Laboratory method (TIGGILLS), teachers' Instructional Guide on Conventional Lecture Method (TIGCLM), evaluation Sheet to Assess Teachers' Performance (ESAT).The reliability co-efficient of the instrument determined using Kuder–Richardson formula 20 was 0.83. Data were analyzed using ANCOVA. There was a significant main effect of Treatment groups on the students' posttest Achievement scores ($F(2,139) = 32.559$, $P < .05$, $\eta 2 = .321$). Group investigative strategy was significantly different from the conventional strategy in their achievement scores. The exposure of the learners to Group Investigative Laboratory method have been found to positively affects the enhancement of students' achievement in Biology.Based on the findings of this study, it was recommended that; in order to improve students' achievement in Biology, Group and individualized instruction strategies are recommended to secondary school Biology teachers for the teaching of Biology.

The above study was related to the present study because they all looked into the performance of students when exposed to laboratory method. Both studies adopted a

pre-test, post-test, control group, quasi –experimental design. The two studies were different because the present study investigate the effects of cooperative and laboratory method on students' performance and retention in chemistry in Jigawa state, Nigeria while the former study looked at the effect of Group Investigative Laboratory method, on students' achievement in Biology in Oyo state. The former study used four instruments for the study and they were; Biology Achievement Test (BAT), Teachers' Instructional Guide on Group Investigative Laboratory method (TIGGILLS), teachers' Instructional Guide on Conventional Lecture Method (TIGCLM), evaluation Sheet to Assess Teachers' Performance (ESAT); while the present study used only one instrument tagged Acid Base Performance test (ABPT)to test both performance and retention of students.

Another research by Adesoji and Olatunbosun (2008) titled student, teacher and school environment factors as determinants of achievement in senior secondary school in Oyo state, Nigeria. The study is aimed at investigating the effects of enhanced laboratory instructional technique on achievement of senior secondary students towards chemistry in Oyo Township, Oyo state of Nigeria.The study adopted ex-post facto research type. The population was made up of 621 senior secondaryIII chemistry students and 27Senior Secondary III chemistry teachers in Oyo State, Nigeria. Four sets of instruments were used, these were chemistry Achievement Tests (SACS), Teacher. Attitude towards Chemistry Teaching Scale (TATCTS) and Laboratory Adequacy Inventory (LAI). The results revealed that 7.20% of the total effect on achievement in chemistry was accounted for by all the seven predictor variables when taken together. It was also revealed that only four variables -school location(X1) laboratory adequacy (X3), teachers' attitude to chemistry teaching(X5) and teachers' attendance at chemistry workshop(X4) had

direct causal influence and also made significantcontributions to the prediction of achievement in chemistry (X8) (the criterion variable).The study adopted an ex-post facto research type. The result revealed that the use of enhanced laboratory method significantly improved performance in chemistry.

The above study was similar to the present study in the sense that they both aimed at investigating the effect of laboratory method among student of chemistry in senior secondary schools. The above research is however different from the present study because the present study investigated the effects of cooperative and laboratory method on performance and retention of students in chemistry in secondary schools in Jigawa state. Unlike the above study which employex-post facto research type, the present study used quasi-experimental design and used t-test and ANOVA to analyze the hypotheses.

Another study outside Nigeria by Leman and Burcin (2010) in Turkey investigated the effectiveness of laboratory related to acids and bases on performance and attitude towards laboratory on high school students. This study aimed to investigate the effectiveness of laboratory works related to '*Acids and Bases*' over teacher centred traditional approach on high school students' learning achievements and attitudes toward chemistry laboratory. The effects of laboratory works were assessed by the participations of 108 10th grade students from four classes in two high schools, which were randomly assigned to experimental (NE-1=21, NE-2 =32) and control (NC-1=24, NC-2 =31) groups. Before the instruction, the pretest (KR-20 = 0.81), applied on all the students to identify their prior knowledge about the basic subjects to learn '*Acids and Bases*', and no significantly differences were found between experimental and control groups in each school ($p>0.05$). While the subject of "*Acids and Bases*" was taught supported with laboratory experiments in the

experimental groups, traditional approach was used in the control groups. The results of the post-test (KR-20 = 0.77), applied after the instruction, indicated that students, who performed experiments was significantly higher mean scores than those of control groups ($p<0.05$). Students' pre and post attitudes towards chemistry laboratory were assessed by using Attitude toward Chemistry Laboratory Scale ($\alpha=0.87$), and found that mean scores of the experimental groups significantly increased from 77.29 to 96.00 and from 80.03 to 97.66 ($p<0.05$). Students' answers to the scale were analysed in four dimensions as (i) Laboratory environment and using equipments; (ii) Experimental process in the laboratory; (iii) Assessment in the laboratory and (iv) Cooperative learning in the laboratory, and significantly increases in the mean scores of experimental group were determined for all the dimensions in comparison with control groups students ($p<0.05$). The findings indicate that students who perform experiments has significantly higher scores than those of control group.

This study looks similar to the present study because they all try to investigate the effects of laboratory method on performance in chemistry. Both studies use the same chemistry concept of acid and base. The two studies were different because the present study has another teaching strategy (cooperative learning strategy) and was conducted in secondary schools in Jigawa state, Nigeria while the other study is carried out in Turkey high schools. The present study used intact classes not randomization as in the case of the former study.

In related development, Yusuf (2011) conducted a study on the effect of cooperative instructional strategy on students' performance in social studies. The objectives of the study among others were to determine the effect of cooperative strategy on students' performance in social studies and also to determine gender

difference on students' performance in social studies. Quasi –experimental and non –equivalent pre –test and post-test control group design was employed in the study. The study was conducted in two junior secondary schools in Ilorin, Kwara state. Sample was selected using simple random sampling technique with ninety three (93) JSS II students as participants. Social Studies Performance Test (SSPT) was the main instrument used to collect data. Hypotheses were analyzed using analysis of covariance (ANCOVA). Findings revealed that there was a statistically significant difference in performance of students taught using cooperative and conventional instructional strategies in social studies.

The above study was related to the present study in that like the former, the present study is aimed at finding out the effects of cooperative strategy on performance. Like the above study, the present study employs quasi-experimental design. However, unlike the above study which was carried out in Kwara state junior secondary schools and in social studies, the present study was conducted on senior secondary schools chemistry students in Jigawa state. The present study also employs two strategies that is, cooperative and laboratory instructional strategies to find out their effects on performance and retention.

Study conducted Ogbeba and Adagbaby (2013) examined the comparative effects of the laboratory and discussion methods on senior secondary students' achievement in chemistry. Three 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 $F(1,195 = 31.90)$, $P<0.05$. The study further revealed that students taught using both laboratory and discussion methods achieved significantly higher with a small class size in terms of student 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 above study was similar to the present study because they were both trying to investigate the effects of laboratory method on performance in chemistry. Both studies have laboratory method as one of the major variable and are all conducted at the senior secondary school level of education in Nigeria. The two studies were different due to the fact that the present study is trying to investigate the effects of both cooperative and laboratory method on performance and retention on students whereas the above study examined the comparative effects of the laboratory and discussion methods on senior secondary students' achievement in chemistry. The present study is based on six hypotheses while the above study is based on three hypotheses. The present study considered t-test and ANOVA to analyze the hypotheses while the above research used ANCOVA.

Sheikhi, Zainailipoor and Jamri (2012) conducted a study to investigate and compare the effect of cooperative learning with an emphasis on jigsaw technique on the academic performance of 2nd grade middle school students in district 1 of Bandar Abbas city (Iran). The design was pre-test, post-test quasi-experimental with

experimental and control groups. The population consist of 4126 students, 1961 girls and 2165 boys. The sample size included 153 students, 89 were girls and 64 were boys. The jigsaw model of cooperative learning was applied to experimental group and the traditional method of instruction was used for the control group. Analysis of covariance was used to test the hypotheses. It was found out that jigsaw model improves students' academic performance.

The above study is similar to the present study because both aimed at investigating the effect of cooperative learning particularly jigsaw model on students on performance. Also, both studies used quasi-experimental research design. The two studies are different due to the fact that the present study investigated the effects of both cooperative and laboratory method on performance and retention unlike the above study which works with only cooperative learning strategy. The above study was conducted outside Nigeria (Iran) whereas the present study was conducted in Jigawa state, Nigeria.

In a similar direction, Özmen et-al. (2012) examined the effectiveness of an intervention based on a series of laboratory activities enhanced with concept cartoons. The purpose of the intervention was to enhance students' understanding of acid-base chemistry for eight grade students' from two classes in a Turkey. The design was pre-test, post-test quasi-experimental with experimental and control groups.The subjects for the study consisted of 36 eighth grade students (19 boys, 17 girls) from two intact classes. One class (N = 19; 11 boys and 8 girls) was assigned as the experimental group (EG) and the other (N = 17; 8 boys and 9 girls) was chosen as the comparison group (CG).Acid-Base Achievement Test (ABAT) and students' interview were the instruments used to collect data in the study.The content validity of the test was established by a commission consisting of three

chemistry educators from the university, two-experienced chemistry teachers and six science and technology teachers.The reliability of the instrument was estimated to be 0.83. The data were analyzed using independent t-test. The finding revealed that the intervention enhanced students' understanding for acid-base chemistry, and hands-on nature of the practical works and concept cartoons were particularly helpful for the students. Also the finding show that combining the pedagogies of laboratory-based activities and concept cartoon may be a useful strategy for teaching acid-base concepts. It was recommended thatlaboratory activities enhanced with concept cartoons also needs to be integrated with some other contemporary teaching methods to be more effective in enhancing students' learning of acid-base chemistry concepts. Researchers may also improve their approach by integrating new teaching methods into this cooperation.

The above study is similar to the present study because they both trying to investigated the effects of laboratory method on performance in chemistry using the concept of acid and base. Both studies adopted quasi-experimental research design. The present study is different from the above study in the sense that it considered cooperative and laboratory method on students' performance and retention in chemistry, and the location of the research was Jigawa state, Nigeria, whereas the above study was conducted in Turkey and it combines laboratory and cartoons as its teaching approaches.

In another study conducted by Haliru (2015) titled the effects of cooperative learning strategy on the academic performance of students in geography in senior secondary schools in Sokoto state Nigeria. The objectives of the study among others are to; determine the difference between the academic performance of students taught geography using cooperative learning strategy and those taught with

traditional lecture methods in sokoto state; examine the extent to which cooperative learning strategy affects the academic performance of students in geography in senior secondary schools in Sokoto state as a result of gender differences. Quasi-experimental design involving experimental/control group, pre-test was used for the study. The population consists of 25,220 senior secondary school geography students out of which 15, 870 and 9,350 are male and female respectively. The sample size of the study was made up of 234 SSII students (155 male and75 female participants). The instrument used for data collection was senior secondary school geography Academic Performance Test (SSGAPT) with reliability coefficient of 0.78. Mean and standard deviation were used to respond to all the research questions raised and t-test statistics was used to test all the six null hypotheses. The findings revealed that there is significant difference between the academic performance of students taught geography using cooperative learning strategy and those taught using traditional lecture method in senior secondary schools in Sokoto state. It was also found out that there is significance difference in the academic performance of urban and rural students when exposed to cooperative learning strategy. Based on the findings it was recommended that CLS should be used as alternative strategy to improve the teaching and learning of senior secondary school geography.

The study is similar to present one in that, it employed cooperative learning strategy on students' academic performance and quasi-experimental design was used. T-test statistics was used in testing the hypotheses. The present study is different to the above study because it investigated the effects of cooperative and laboratory method on performance and retention of students in chemistry. The present study was also different from the above study in that it uses both t-test and ANOVA in analyzing the hypotheses.

In related development, Tarhan andSesen (2010) conducted a study titled investigation the effectiveness of laboratory works related to acids and bases on learning achievements and attitudes towards laboratory. The research was aimed atinvestigating the effectiveness of laboratory works related to 'Acids and Bases' over teacher centred traditional approach on high school students' learning achievements and attitudes toward chemistry laboratory. Quasi-experimental research design was adopted for this research. The effects of laboratory works were assessed by the participations of 108 10th grade students from four classes in two high schools, which were randomly assigned to experimental (NE-1=21, NE-2 =32) and control (NC-1=24, NC-2 =31) groups.The subject of "*Acids and Bases*" was taught supported with laboratory experiments in the experimental groups, traditional approach was used in the control groups.The results of the pilot test was analyzed and a reliability index of (KR-20 = 0.77) was obtained. Students who performed experiments has significantly higher mean scores than those of control groups ($p<0.05$). It was found out that there is cooperation among learners in the laboratory, learners use materials and equipment during laboratory work and that laboratory work enhance performance.

The above study is similar to the present study because the two are trying to investigate the effectiveness of laboratory method on students' performance. Again, the two studies used acid and base concept as their topic. Also both study used quasi-experimental research design. But the present study is different to the above one because it employs two strategies i.e. cooperative and laboratory method on students' performance and retention. Also the present study used intact classes not random sampling.

Olorukooba (2001) conducted a study titled the relative effects instructional strategy and traditional method on the performance of senior secondary schools chemistry students. The study was aimed at investigating the effects of CL on students' achievement in chemistry. The study adopted quasi-experimental research design. The sample size used in the study consisted of 264 students, (N-137) for control and (N-127) for experimental group. The study used t-test and Mann Whitney U-test statistics at 0.05 level of significance. The study revealed that the experimental group performed significantly better in the achievement test than the control group, with no significant difference in the academic achievement of boys and girls taught using CL instructional strategy. It was also found out that boys and girls differed significantly in their attitude toward CL with boys having more favorable attitude than girls.

The above study is related to the present study because they are all trying to investigate the effects of cooperative learning strategy on performance among secondary schools chemistry students. Both studies used t-test statistics in analyzing the data. The two study also used quasi-experimental design. However, the two studies were different because unlike the above, the present study considered cooperative and laboratory- based strategies on students' performance and retention in chemistry. Also, the present study used both t-test and analysis of variance in testing the data.

In a similar study, Abdullahi (2014) conducted a research on the effects of cooperative learning strategy on self-efficacy, and academic achievement in chemistry among formal and concrete reasoners in Colleges of Education in North-West Zone, Nigeria. Quasi experimental control group design employing pre and posttests was used for the study. The population of the study comprised of 820 level

200 chemistry students of state Colleges of Education in the North-West Geopolitical Zone of Nigeria. The sample size consist of 96 students as experimental group comprising 79 males and 17 females, while the control group had a total of 84 students comprising 63 males and 21 females. Hence the total number of subjects used as sample in the two colleges was 180 subjects. Three instruments were used to collect data for this study which are; Chemistry Achievement Test (CAT), General Self-Efficacy Scale (GSES) and Test of Logical Thinking (TOLT). The data collected from the administration of the instruments were analyzed using t-test statistical tool in order to test the stated hypotheses.The reliability coefficient of the items in the Chemistry Achievement Test (CAT) is 0.74, while the reliability of the items in the Test of Logical Thinking (TOLT) is 0.73.The data collected from the administration of the instruments were analyzed using t-test statistics andPearson moment correlation coefficient.The major findings from the analysis of the data in this study among others include; Cooperative learning strategy significantly improves the academic achievement of chemistry students who were exposed to it; the use of cooperative learning strategy had significant effect on the academic achievement of formal 'reasoners' more than that of the concrete reasoners. The difference in academic achievement between formal and concrete students was found to be statistically significant; and the difference between self-efficacy of students exposed to Cooperative learning strategy and those exposed to lecture method was not statistically significant.

The above study is similar to the present one because they all aimed at investigating the effects of cooperative learning strategies on students' performance in chemistry. All the two study used quasi experimental research design and they adopted Jigsaw cooperative learning model. The hypotheses were analyze using t-test statistics. In

contrary, the present study used both t-test and analysis of variance in testing the hypotheses. Also the present study employed cooperative and laboratory method on performance and retention of students in chemistry.

In the study of Omwirhiren (2015) titled theacademic achievement and retention in chemistry is enhanced using the two instructional methods among SSII students and ascertained the differential performance of male and female students in chemistry with a view of improving student performance in chemistry. The study adopted a non-equivalent pretest, posttest control quasi-experimental design. A total of one hundred and eighteen senior secondary school II students in intact classes were chosen from three schools in Gboko Local Government Area of Benue State using purposive random sampling. The hypotheses were generated and tested which were tested at 0.05 level of significance. The data obtained were analyzed using descriptive statistics, t-test, spearman's correlation coefficient and analysis of variance (ANOVA).The overall results showed that discussion instructional strategy significantly improved students' performance and retention in chemistry better than the lecture instructional strategy.

The study above indicated similarity with the present study in the sense that SSII students' performance and retention abilities in chemistry. Both study adopted quasi-experimental design and data were analyzed using t-test and ANOVA in both study. The two study were different because the above study used discussion and lecture method while the present study considered cooperative and laboratory method. The present study was conducted in Jigawa state while the above study was conducted in Gboko Local Government Area of Benue State.

In a similar vein, Goje (2014) investigated the effects of laboratory teaching and lecture methods on academic achievement and attitude to acid and base concepts in

chemistry among senior secondary 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 is 146 students. Acid Base achievement Test (ABAT) is 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 laboratory method in the teaching and learning of chemistry.

The above study is related to the present study because they all try to investigate the effects of laboratory method on performance of students in chemistry. Both study employed quasi-experimental research design on senior secondary school II chemistry students, and the topic for both study is acid and base concepts. Hypotheses in both studies were analyzed using t-test statistics. But in the contrary, the present research employed both t-statistics and analysis of variance in analyzing the hypotheses. The present study was also different from the above study because it considered effects of cooperative and laboratory method on performance and retention of students in chemistry.

Virtually, all the above reviewed literatures claimed that cooperative and laboratory-based learning strategies promote academic performance and retention ability in chemistry. This is all what aroused the researcher's attention to examine the

effectiveness of cooperative and laboratory method in learning chemistry concepts. Thus, these studies will be carried out in government owns schools. This study is therefore, intended to further investigate these claims with regard to chemistry as a science subject at government owns senior secondary schools. Therefore, the aim of this study is to investigate the effects of cooperative and laboratory method on performance and retention of students in chemistry in secondary schools. To compare these strategies with the traditional lecture method and see which of the strategies is more effective.

2.12 Summary

Literature reviewed in this chapter covered broad range of issues related to the present study. Literature related to the various variables in this study like cooperative strategy, laboratory method, lecture method, academic performance, students' retention ability and so forth, were reviewed. The literature reviewed provides an insight into the relevance of cooperative and laboratory method on enhancing the performance and retention ability of students in chemistry and other related science subjects.

From the literature examined, some significant observations that have implication to this study were made thus: the literature reviewed in this study indicated that cooperative learning method can be apply in any academic level from kindergarten to colleges and it promote positive learning habit in the learner. Poor performance in chemistry attests to the fact that science teaching has not been properly done, or wrong approach has been adopted. For science teaching (chemistry) to be properly conveyed, there is need for the choice of the appropriate instructional strategy/method, which will in turn aid performance. In this regard cooperative learning strategy was proved to be a good learner teaching method which can engage

students to work together in small groups thereby enhancing performance and retention ability of students in chemistry. Most of the literatures reviewed here indicated that cooperative learning strategy encourage students to work together and help each other during teaching and learning. From the literature, it was also indicated that teachers often use conventional method than alternative instructional methods/strategies like cooperative and laboratory method.

The literature also revealed that laboratory method shared the idea that students most work in a laboratory environment to learn and each member is ready to learn. It has also been revealed from the literature that consistent and continues elaboration or explanation of a topic brings about forth complete retention of a topic being learnt for a longer period of time.The reviewed literatures also revealed that poor performance in science subject particularly chemistry, required an effective method of teaching the subject, so as to improve the performance of students in the subject. Therefore, the literatures emphasized that science(chemistry) teachers should employ the use of laboratory method in teaching science concept in order to improve students' performance and retention ability.

Various literatures suggested that there was availability of laboratories in some of the schools where related empirical studies were conducted, though some of these laboratories are ill-equipped. In the same vein, studies proved that laboratory method improves students' performance and retention in chemistry and acid-base concept in particular at various places where similar studies were conducted. By implication, teachers need to shift from the conventional lecture method to alternative instructional strategies like cooperative and laboratory method as this may improve students' performance and bring complete retention ability which had already been identified as low globally, nationally and locally.

It has been discovered in this literature that cooperative and laboratory method with respect to acid-based concepts in senior secondary schools was not conducted in Jigawa state. As far as the researcher is concerned from the literature available, this study might be number one to combine cooperative and laboratory method in Jigawa state, therefore, this study filled the gap that no single study of its kind have been conducted in Jigawa state.

Based on this premise, if the strategy and the method used in this study are applied properly, there is going to be a good performance and complete retention of students in learning of chemistry in general, and the concept of acid and base by secondary school students in particular. The researcher therefore, wishes to make efforts to employ cooperative learning and laboratory method to teach senior secondary chemistry students in Jigawa state the concept of acid and base, to see if it could improve their performance and retention after treatment using the mentioned concepts and other chemistry concepts in general.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This study is aimed at determining the effects of cooperative and laboratory method on performance and retention among secondary schools chemistry students in Jigawa state, Nigeria. This chapter presented a general outline on the methodology to be used in conducting the study. The chapter is presented under the following sub – headings: introduction, research design, population, sample and sampling techniques, determinant of sample homogeneity, instrumentation, table of specification, validity of the instrument, pilot study, reliability of the instrument, procedure for data collection, treatment procedure, control of extraneous variables and procedure for data analysis.

3.2 Research Design

This study employed pre-test, post-test quasi – experimental and control group design. This according to Akuezuilo cited in Abdullahi (2014) involves two groups in which one group is assigned as experimental and the other control group. All the two groups were pre-tested to determine their entry level. The study used three groups; experimental group one (EG_1), experimental group two (EG_2) and control group (CG). Experimental groups (EG_1 and EG_2) were exposed to cooperative and laboratory method of teaching as treatments (X_1 and X_2), while control group (CG) was taught the concepts using lecture method (X_0). The two groups (experimental and control) were pre – tested (O_1) on academic performance and retention to ensure that samples selected are not significantly different in terms of academic performance and retention before treatment. The two groups were taught the concepts of acid and base for a period of eight (8) weeks. Then post-test (O_2) was

administered to the groups in order to determine the effects of cooperative, laboratory and lecture methods of teaching on academic performance and retention on the concepts of acid and base to senior secondary two (II) chemistry students. The retention test (O_3) was administered four (4) weeks later to all the groups in order to determine the level of the retention on the concepts of acid and base to senior secondary two (II) chemistry students. The research design illustration of the study which has been recommended by Kerlinger and Frankie cited in Shehu (2016), is adapted and represented below:

$EG_1 \longrightarrow O_1 \longrightarrow X_1 \longrightarrow O_2 \longrightarrow O3$

$EG_2 \longrightarrow O_1 \longrightarrow X_2 \longrightarrow O_2 \longrightarrow O3$

$CG \longrightarrow O_1 \longrightarrow X_0 \longrightarrow O_2 \longrightarrow O3$

Figure 1: Research Design Illustration

Where:

EG_1 = Experimental Group 1 (cooperative strategy)

EG_2 = Experimental Group 2 (laboratory strategy)

CG = Control Group

X_1= Cooperative Strategy

X_2= Laboratory – Based Strategy

X_0= Traditional Lecture Method of Teaching

O_1 = pre - test

O_2 = Post - test

O_3 = Retention test

3.3 Population

The total population of SS II chemistry students in Jigawa state is nine thousand three hundred and fifty seven (9357) which cuts across the nine educational zones

(see appendix H). Whereas the target population used for this study is one thousand three hundred and thirty two (1332) senior secondary school two (II) chemistry students of Kazaure education zone, Jigawa state, Nigeria. Based on the record from the monitoring and evaluation division of Jigawa state Education Resource Department, Kazaure education zone consists of eleven (11) public schools, and all the eleven (11) schools are single sex schools; the age range of the students is between 16 – 20 years. The detail of the list of the schools is given in Table 1

Table 1: Population of the Study

S/N	Name of School	Type of School	Gender	SS2 Chemistry enrolment
1	GDSS KORIYAL	Day		78
	GDSS GWIWA	Day	Male	40
	GDSS GADA	Day	Male	34
2.	GGDSS KAZAURE	Day	Male Female	110
3.	GSS RONI	Boarding		262
4.	GDSS AMARYAWA	Day	Male	52
	GSTC KARKARNA	Boarding	Male	199
5.	GSS KAZAURE	Day	Male	92
		Day	Male	53
6.	GDSS FIRJI	Boarding	Male	246
	CGSS RONI		Female	
	GGSS	Boarding		166
7.	KAZAURE		Female	
	Grand Total			**1332**
8.				
9.				
1 0.				
1 1.				

Source: Monitoring and Evaluation Division of Jigawa Education Resource Department (2017)

3.4 Sample and Sampling Techniques

The sample size for this study is three hundred and four (304) which was arrived at using purposive sampling technique. As quasi-experimental design does not allowed randomization, intact classes were used for the study which is in line with Cohen, Manion and Morrison (2007). A total number of six schools drawn from the eleven (11) secondary schools were used as samples; where four schools represented experimental groups (two schools as experimental group I and two schools as experimental group II), and two schools were used as control group respectively. The six intact classes has the total number of three hundred and four (304) students (Experimental and Control groups) which were used as sample. The selections of the schools were purposive in order to allow equal chance of the girls/boys and day/boarding schools being represented. The sample distribution is represented in Table 2:

Table 2: Sample Distribution for the Study

S/N	Name of Schools	Gender	Group	No. of Sample	Total
1.	GSS KAZAURE	Male	Experimental 1 (Cooperative)	42	42
2.	GGSS KAZAURE	Female	Experimental 1 (Cooperative)	46	46
3.	GSS RONI	Male	Experimental 2 (Laboratory)	50	50
4.	CGSS RONI	Female	Experimental 2 (Laboratory)	53	53
5.	GDSS AMARYAWA	Male	Control	52	52
6.	GGDSS KAZAURE	Female	Control	61	61
	Total				**304**

3.4.1 Determinant of samples Homogeneity

To ascertain the homogeneity of the samples, schools which are public own and under the supervision and control of the state ministry of education were considered as samples. The sample schools falls under Kazaure zonal education office/Kazaure emirate council where the students have similar culture and tradition. Four schools (one male/female and another male/female schools) were used as experimental groups respectively. In the same vein, one male and one female school are considered as control group. Both rural and urban schools were used as samples in order to ensure sample homogeneity.

3.5 Instrumentation

The instruments used for this study is tagged Acid Base Performance Test (ABPT) which was developed by the researcher. The instrument is made up of two parts (A & B), Part A considered basic information like school name and gender while part B covered the ABPT section. This instrument consist of fifty (50) multiple objective test items each to determine the academic performance of students in acid and base concepts of secondary schools two (SS II) chemistry syllabus and ABPT constructed based on the selected topics for the treatments. The topics selected were; acids, bases,introduction to apparatus and materials, volumetric analysis, acid –base titration,standard solution, and the pH scale. The Table of Specification is based on Blooms Taxonomy as represented in table 3.

3.5.1 Table of Specification

The table of specification is about the blue print of the ABPT test. The concentration of the table was on the content areas covered and the relative emphasis was placed on all areas and instructional objectives. Akem (2006) viewed table of specification as a guide to assist a teacher or examiner in the evaluation system.

S/N	Content	Weight (%)	Knowledge (25)	Comprehensive (23)	Application (15)	Analysis (13)	Synthesis (12)	Evaluation (12)	Total no. of items
1	Acids	22	4	3	1	1	2	1	12
2	Bases	20	3	2	1	1	1	1	9
3	Neutralization reaction	20	2	2	3	1	1	1	10
4	Mass volume relationship	20	3	2	2	2	1	1	11
5	pH scale	18	2	1	1	2	1	1	8
	Total	**100**	**14**	**10**	**8**	**7**	**6**	**5**	**50**

Table 3: Specification for a (50) items Acid Base Performance Test for SS2.

Source: Adapted from: Obeka (2009)

From the table, it would be seen that of the five subject matter areas, acids attracted the highest number of items (that is 12) and the pH scale, had the least (that is 8). And for weight of contents the knowledge level had (14) items as the highest and the evaluation had the least.The distribution of number of items in each cell (that is for each level of the subject matter) is a reflection of the emphasis and the importance the researcher attached to these areas. This table of specification is designed to guide the researcher in constructing the test items or questions. This must be in line with what has been specified in the table specification.

3.5.2 Treatment Package

The treatment package usually guide the teacher to relate his objectives to cognitive as well as affective level of achieving the learning goals. Since teachers cannot ask every question or measure their achievement accurately, thus the idea of treatment package. A teacher construct a test in order to focus on the key areas and the weight of questions related to the questions. Therefore the treatment package for this study is presented in Table 4:

Table 4: Treatment Package

S/N	Topic	Cognitive Domain		Affective Domain		Total
		Knowledge	Comprehension	Receiving	Responding	
1.	Acids	1,3,16,31,34,	41,45,12	17	14,36.40	**12**
2.	Bases	4,35.42	44,47	20,22	20	**8**
3.	Neutralization reaction	2,5,7	43,18,21	15,19,,24	38,26	**11**
4.	Mass volume relationship	48,11	49	13,23 6,8,10,25,46,49		**11**
5.	pH scale	33,39	37,30	27	28,29,32	**8**
	Total	**1511**		**915**		**50**

3.5.3 Validity of the Instrument

The instrument was validated by experts from the field of curriculum, who are not below the rank of senior lecturer in the Faculty of Education, Department of Educational Foundations and Curriculum, Faculty of Education Ahmadu Bello University Zaria Also experts from test and measurement, Science Education, both from Ahmadu Bello University Zaria, and a lecturer (Professor) from the Department of Chemistry Bayero University Kano validated the instrument. They studied the instrument and clarify the questions on whether they are testing what they are meant to test, examine whether the items are clear to avoid ambiguity, certify if the questions are appropriate for the level of the students under the study and check for possible errors in the instrument and suggested the corrections to be made. It was suggested that time for answering the instrument should be provided which was not initially indicated on the instrument. It was also advised that on item

8 option d, indicator should be corrected to indicators. Also on item 23 option c, concentration should be replaced with basic among others.

3.5.4 Pilot Study

A pilot study was conducted in two of the senior secondary schools which are not part of the study sample but part of the population (GCSS Karkarna and GDSS Firji), to determine the reliability of the instruments. The schools selected for this purpose are similar to those schools of the main study in terms of location, ownership and status level. ABPT was administered to these students using test – retest method with an interval of two weeks. The main purpose of pilot study according to Kerlinger and Howard in shehu (2016) is to confirm the suitability of the instrument for its adequacy and effectiveness. The items in the instruments was calculated from the result of the pilot study using the split half method. The scores were splited in to equivalent halves, arranged as odd and even numbered items. The score of the two halves were correlated using Pearson Product Moment Correlation Coefficient (PPMCC) to estimate the reliability of the instrument. The purpose of the pilot study is to get reliability coefficient of the instruments. However, the pilot testing was conducted under a very strict condition and no student was allowed to go out with the question paper in order to avoid leakage of the questions in the instruments which may in turn affect the final post-test and retention test results.

3.5.5 Reliability of the Instrument

To test the quality of the ABPT instrument used in this study, the test – retest method was used. The instrument was administered to the group of forty (40) students and Pearson Product Moment Correlation Coefficient (PPMCC) formula was used to determine the reliability of the instrument. The test was administered on two different occasions at two weeks interval as recommended by Tuckman cited in

Shehu (2016). Related to this, Sambo (2005) opined that the score from the two administrations correlated can be considered as an estimate of the reliability of the test. The reliability of the ABPT after correlation is 0.79, which showed that the instrument is reliable and be used for data collection in this study (appendix F).

3.6 Procedure for Data Collection

The researcher obtained the data on performance by administering the instrument through pre – test, post – test and retention test to the senior secondary schools (SSII) chemistry students in the experimental and control groups. The students in the experimental groups were exposed to cooperative and laboratory – based strategies under the researcher's guidance, while the students in the control groups were exposed to the conventional teaching method on the same contents used for the experimental groups, also facilitated by the researcher.

3.6.1 Treatment Procedure

In administering the instruments, the Experimental group one (cooperative), Experimental group two (laboratory) and the control group (lecture method) were considered. The treatment plans on how the instruments was administered to both the two experimental groups, that is, (cooperative and laboratory method) and the control group (lecture method) is explained as follows:

Treatment Plan for the Experimental Group One (Cooperative)

Teaching in the experimental group one was conducted by the researcher using the cooperative learning strategy (the jigsaw model). This enabled the researcher to effectively handle the treatment group following all the necessary criteria for the adoption of the method.

In administering the instrument using this strategy, students were assigned in to groups to work on academic material that has been broken down into sections. The

teacher introduced the lesson to the students and explained to them what they are expected to do. For example, the concept of acid and base were divided into meaning and types, characteristics and properties.

The students in thisexperimental group received treatment on the concept of acid, concept of base, introduction to materials and use of apparatus in volumetric analysis, volumetric analysis, standard solution, acid base titrations, the pH scale and introduction behind experiments, and general discussion on problems faced during acid base titrations by the researcher. The concept of acid, as lesson one (1) and taught in the first week, concept of base was presented as lesson two (2) and taught in the second week, introduction to materials and use of apparatus in volumetric analysis was presented as lesson three (3) and taught in the third week, volumetric analysis was presented as lesson four (4) and taught in the fourth week, standard solution was presented as lesson five (5) and taught in the fifth week, acid base titration was presented as lesson six (6) and taught in the sixth week, the pH scale was presented as lesson seven (7) and taught in the seventh week, and introduction behind experiments and general discussion on problems faced during acid base titrations was presented as lesson eight (8) and taught in the eighth week respectively.

In this treatment group, Jigsaw groups were first formed which consisted of small groups of students (5-6) as members. Each team member was assigned a task to reads his or her section during the lesson. Next, members of different teams (Jigsaw) who had studied the same tasks/sections met in expert groups and discussed their ideas on the area assigned to them. Then the students returned to their teams and took turns explaining the area they studied to their team mates.

This treatment procedure followed for all the remaining lessons. Treatment for the experimental group lasted for eight (8) weeks after which a post- test was administered to determine the effect of treatment on the students' performance. A retention test followed to determine the level of retention ability of students after four (4) weeks which according to Madu and Ezeudu cited in Onuoha (2010), stated that two weeks interval was long time enough to take care of the possibility of students to go for retention test. As such this study used four (4) weeks interval for a better retention result.

The adopted model for cooperative strategy is illustrated in Figure 2.

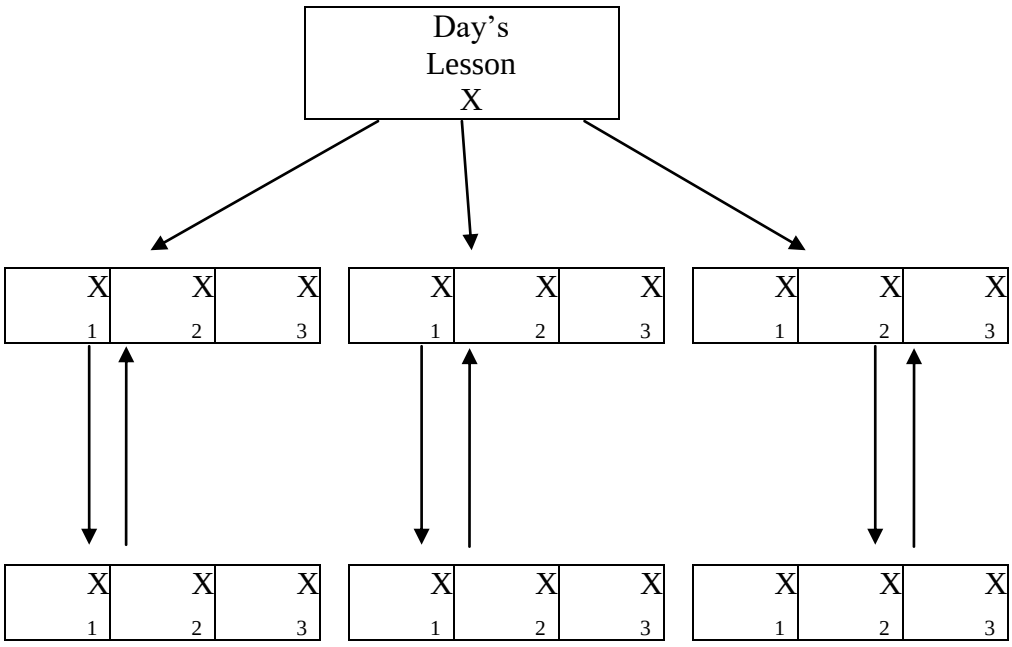

Fig. 2: Jigsaw model flow chart

Treatment Plan for the Experimental Group Two (Laboratory)

The researcher administered the instrument to this group using laboratory-based instructional strategy. The sampled schools selected for this strategy all have functioning laboratories which served as a suitable environment for administering this treatment. Here the researcher with the aid of the laboratory attendants and the chemistry teachers arranged the laboratory for the activities. The treatment takes

eight weeks where by the researcher gave the background information during introductory session and guided the students to conduct the actual laboratory work with the help of the laboratory attendant. The laboratory attendant assisted in arranging the materials and in making sure that they function effectively during the treatment.

The students in thisexperimental group were taught the concept of acid, concept of base, introduction to materials and use of apparatus in volumetric analysis, volumetric analysis, standard solution, acid base titrations, the pH scale and introduction behind experiments and general discussion on problems faced during acid base titrations by the researcher. The concept of acid, as lesson one (1) and taught in the first week, concept of base was presented as lesson two (2) and taught in the second week, introduction to materials and use of apparatus in volumetric analysis presented as lesson three (3) and taught in the third week, volumetric analysis was presented as lesson four (4) and taught in the fourth week, standard solution was presented as lesson five (5) and taught in the fifth week, acid base titration was presented as lesson six (6) and taught in the sixth week, the pH scale was presented as lesson seven (7) and taught in the seventh week, and introduction behind experiments and general discussion on problems faced during acid base titrations was presented as lesson eight (8) and taught in the eighth week respectively.

This treatment procedure followed for all the remaining lessons as earlier stated in treatment of the experimental group one. The treatment of both the two experimental groups took place subsequently and lasted for eight weeks after which a post- test was administered to determine the effect of treatment on the students' performance. A retention test followed to determine the level of retention ability of students in

chemistry after four (4) weeks. The lessons was guided using the flow chart developed by the researcher as shown below:

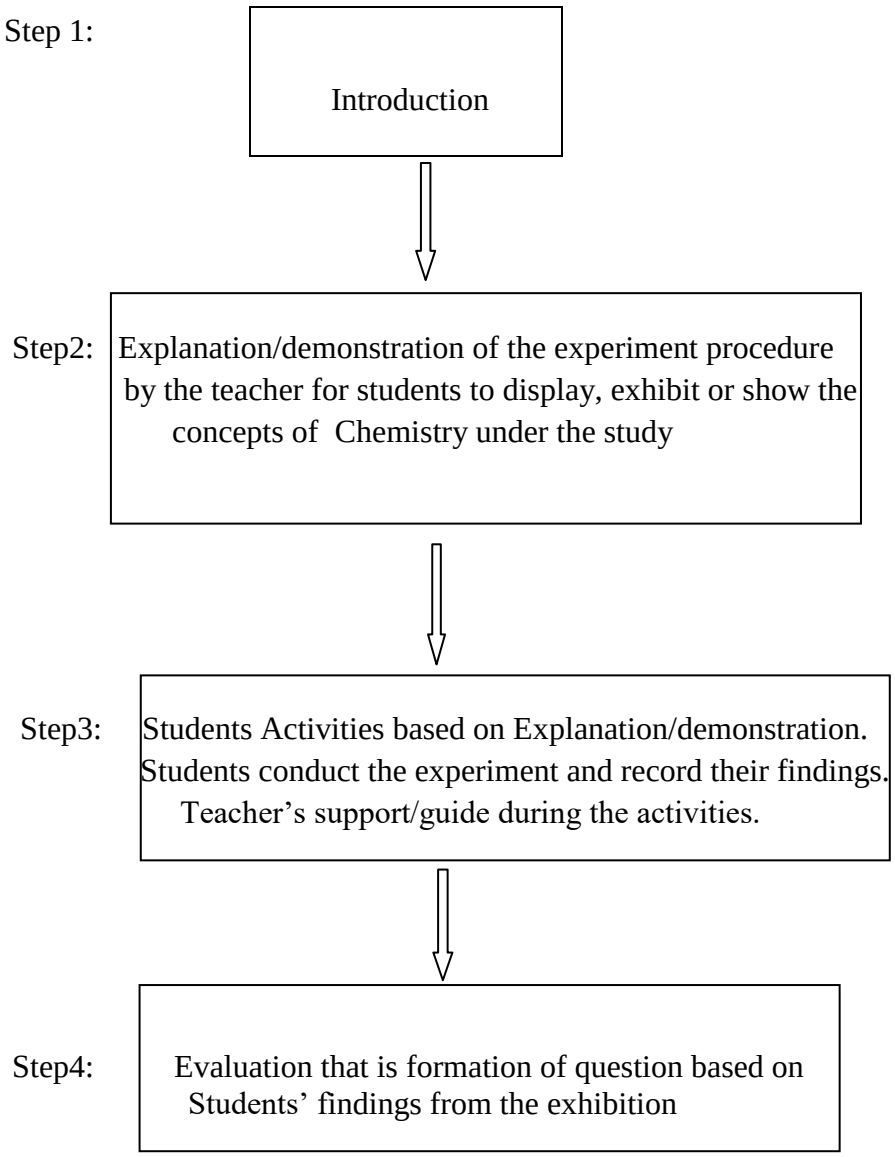

Figure 3: Umar's flow chart on lesson for Experimental Group 2 (Laboratory Strategy)

Treatment Plan for the Control Group (Lecture method)

The students in the Control Group were taught the concept of acid, concept of base, introduction to materials and use of apparatus in volumetric analysis, volumetric analysis, standard solution, acid base titrations, the pH scale and introduction behind experiments and general discussion on problems faced during acid base titrations by

the researcher. The concept of acid, as lesson one (1) and taught in the first week, concept of base was presented as lesson two (2) and taught in the second week, introduction to materials and use of apparatus in volumetric analysis was presented as lesson three (3) and taught in the third week, volumetric analysis was presented as lesson four (4) and taught in the fourth week, standard solution was presented as lesson five (5) and taught in the fifth week, acid base titration was presented as lesson six (6) and taught in the sixth week, the pH scale was presented as lesson seven (7) and taught in the seventh week, and introduction behind experiments and general discussion on problems faced during acid base titrations was presented as lesson eight (8) and taught in the eighth week respectively. The lesson was conducted for eight weeks, subsequently with the experimental groups.

3.6.2 Control of Extraneous Variables

Variables which are related to the research but are not studied in this research were considered to be extraneous variables. According to Turner (2015), extraneous variables are unwanted factors in a study that, if not accounted for, could negatively affect the data subsequently collected. To control extraneous variables in this study, the schools location were considered that is, both urban and rural location of schools in order to have equal representation of the population. Issue of gender was also taken care of, because male schools and female schools were selected as samples. The schools are single sex schools and the age range of the students is between 16 – 19 years. All the schools selected are public secondary schools under the care and supervision of state ministry of education and zonal education office. Moreover, for the experimental group two (laboratory), schools with well-equipped and functioning laboratory were selected as samples to aid the smooth running of the

treatments. Also to make sure that there is equal chances of representation, both day and boarding school were considered as samples in this study.

3.7 Procedure for Data Analysis

The data collected from the administration of the instruments 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 reason for the use of t-test is because t-test is a statistical tool which compares the actual difference between two means as expressed in standard deviation of the difference between the means (Clarke & Cook, 2007). ANOVA is used to determine whether there are significant differences between two or more independent (unrelated) groups on a dependent variables (Keselman, Huberty, Lix, & Olejnik, 2016). Based on this premise, the hypotheses formulated for this study will be retained or rejected at an alpha of 0.05 level of significance.

CHAPTER FOUR
DATA PRESENTATION, ANALYSIS AND DISCUSSIONS

4.1 Introduction

In this chapter, the researcher present the results, analysis and discussions of the research findings. The data were generated using Acid Base Performance Test (ABPT) as an instrument for data collection. The data collected were analyzed using the Statistical Package for Social Science (SPSS) version 20 which forms the basis of analyzing the six research questions at descriptive level the six formulated hypotheses at inferential level. 0.05 alpha level of significance was adopted for retaining or rejecting the stated hypotheses.

However, the pretest data were used to establish the equivalence of the three groups before the experiment. To achieve this, the pretest mean scores of the experimental and control groups were subjected to ANOVA statistic. The result shows no significant difference between the mean scores. This implies that the group shows equivalence with respect to their knowledge acid base concepts. Summary of ANOVA analysis for the pretest are shown in the Appendix I.

4.2. Answering of Research Questions

In this study, six research questions along with corresponding hypotheses were formulated for answer and analysis respectively. The first research question is responded to as follows:

1. **Research Question One:** What is the mean score difference in academic performance of chemistry students taught using cooperative learning strategy and those taught with conventional method?

To answer the above research question, the result of the post-test scores was consideredand descriptive statistics of mean and standard deviation were used, as tabulated in Table 5.

Table 5: Mean Academic Performance Scores of Students Exposed to Cooperative Learning and those exposed to Lecture Method

Learning Strategies	N	Mean	Std. Deviation	Std. Error Mean
Cooperative	88	57.6250	13.14492	1.40125
Lecture	113	45.7257	13.49156	1.26918

The result in Table 5 shows that the mean academic performance score of 57.63 and standard deviation of 13.14 for students who were exposed to the cooperative learning strategy was higher than the mean score of 45.73 and standard deviation of 13.49 for students who were exposed to the lecture method. The mean scores are far better than the standard deviation scores which revealed the existence of difference in the performance of the two groups. This difference could be regarded as the improvement achieved or the degree of enhancement of the students' academic performance that could be attributed to the use of the cooperative learning strategy adopted in the study. The result indicated that students taught the concept of acid and base using cooperative learning strategy have a better mean score than those taught the same concept using conventional (lecture) method of teaching in secondary schools in Jigawa State. The significance of this variability in the academic performance between the two groups is tested in the corresponding hypothesis.

2. **Research Question Two:** What is the effect of cooperative learning strategy on students' retention ability in chemistry?

To answer research question two, a descriptive statistics of mean and standard deviation were used from the result of the retention test as tabulated in Table 6.

Table 6: Mean Academic Retention Ability Scores of Students Exposed to Cooperative Learning and those exposed to Lecture Method

Learning Strategies	N	Mean	Std. Deviation	Std. Error Mean
Cooperative	88	60.1705	13.93270	1.48523
Lecture	113	40.8230	12.74351	1.19881

Table 6 revealed that the mean academic retention scores of the two groups that is Cooperative and Lecture methods were 60.17 and 40.82 with standard deviation of 13.93 and 12.74. This mean scores are differing with the standard deviation scores which revealed the existence of difference in the performance of the two groups. It's clear from the figures above that the Experimental group exposed to cooperative strategy performed better than their counter part exposed to lecture method. This difference could be regarded as the improvement achieved or the degree of enhancement of the students' retention ability that could be attributed to the use of the cooperative learning strategy adopted in the study. The result indicated that students taught the concept of acid and base using cooperative learning strategy have a better mean score than those taught the same concept using conventional (lecture) method of teaching in secondary schools in Jigawa State. The significance of this variability in the academic retention ability between the two groups is tested in the related hypothesis.

3. **Research Question Three:** What is the mean score difference in academic performance of chemistry students taught using laboratory method and those taught with conventional lecture method?

To answer the above research question, the result of the post-test scores was consideredand descriptive statistics of mean and standard deviation were used, as tabulated in Table 7.

Table 7: Mean Academic Performance Scores of Students Exposed to Laboratory method and those exposed to Lecture Method

Learning Strategies	N	Mean	Std. Deviation	Std. Error Mean
Laboratory	103	63.4660	14.32043	1.41103
Lecture	113	46.7434	14.33202	1.34824

The result in Table 7 shows that the mean academic performance score of 63.47 and standard deviation of 14.32 for students who were exposed to the Laboratory method was higher than the mean score of 46.74 and standard deviation of 14.33 for students who were exposed to the lecture method. This mean scores are differing with the standard deviation scores which revealed the existence of difference in the performance of the two groups. This difference could be regarded as the improvement achieved or the degree of enhancement of the students' academic performance that could be attributed to the use of the cooperative learning strategy adopted in the study. The result shows that students taught the concept of acid and base using laboratory method have a better mean score than those taught the same concept using conventional (lecture) method of teaching in secondary schools in Jigawa State. The significance of this variability in the academic performance between the two groups is tested in the corresponding hypothesis.

4. **Research Question Four:** What is the effect of laboratory method on students' retention ability in chemistry?

To answer the above research question, descriptive statistics of mean and standard deviation from the result of the retention test scores were used as tabulated in Table 8.

Table 8: Mean Academic Retention Ability Scores of Students Exposed to Laboratory Method and those exposed to Lecture Method

Learning strategies	N	Mean	Std. Deviation	Std. Error Mean
Laboratory	103	52.7282	13.84380	1.36407
Lecture	113	40.8230	12.74351	1.19881

Source: Field Study Data 2017/2018 Academic Session

Table 8 revealed that the mean academic retention scores of the two groups that is laboratory method and Lecture method were 52.73 and 40.82 with standard deviation of 13.84 and 12.74. This mean scores are differing with the standard deviation scores which revealed the existence of difference in the retention ability of the two groups. It's clear from the figures above that the Experimental group exposed to laboratory method retained chemistry concepts better than their counter part exposed to lecture method. This difference could be regarded as the improvement achieved or the degree of enhancement of the students' retention ability that could be attributed to the use of the cooperative learning strategy adopted in the study. The result indicated that students taught the concept of acid and base using laboratory method have a better mean score than those taught the same concept using conventional method of teaching in secondary schools in Jigawa State. The significance of this variability in the academic retention ability between the two groups is tested in the related hypothesis.

5. **Research Question Five:** What is the difference in performance of students taught chemistry with cooperative, laboratory and conventional methods?

To answer research question five, a descriptive statistics of mean and standard deviation were used from the result of the performance test as tabulated in Table 9.

Table 9: Mean Academic Performance Scores of Students Exposed to Cooperative Strategy, Laboratory Method and those exposed to Lecture Method

Teaching Strategies	N	Mean	Std. Deviation	Std. Error
Cooperative	88	57.6250	13.14492	1.40125
Laboratory	103	63.4660	14.32043	1.41103
Lecture	113	45.7257	13.49156	1.26918
Total	304	55.1809	15.63138	.89652

The result in Table 9 shows that the mean academic performance score of 63.47 and standard deviation of 14.32 for students who were exposed to the Laboratory method was higher than the mean score of 57.63 and standard deviation of 13.14 for students exposed to cooperative strategy, and this was in turn higher than the mean score of 45.73 and standard deviation of 13.49 for students who were exposed to the lecture method. This mean scores are differing with the standard deviation scores which revealed the existence of difference in the performance of the three groups. This difference could be regarded as the improvement achieved or the degree of enhancement of the students' academic performance that could be attributed to the use of the laboratory and cooperative learning strategies adopted in the study. The result shows that students taught the concept of acid and base using laboratory method have a better mean score than those taught the same concept using cooperative strategy. The mean score of students taught the concept of acid and base using cooperative strategy was in turn better than the mean score of students taught the same concept with conventional (lecture) method of teaching in secondary schools in Jigawa State. The significance of this variability in the academic performance between the three groups is tested in the corresponding hypothesis.

6. **Research Question Six:** What is the difference in retention ability between students taught with cooperative, laboratory method and lecture method?

To answer the above research question, descriptive statistics of mean and standard deviation from the result of the retention test scores were used as tabulated in Table 10.

Table 10: Mean Academic Retention Scores of Students Exposed to Cooperative Strategy, Laboratory Method and those exposed to Lecture Method

Teaching Strategies	N	Mean	Std. Deviation	Std. Error
Cooperative	88	60.1705	13.93270	1.48523
Laboratory	103	52.7282	13.84380	1.36407
Lecture	113	40.8230	12.74351	1.19881
Total	304	50.4572	15.62213	.89599

The result in Table 10 revealed that the mean academic performance score of 60.17 and standard deviation of 13.93 for students who were exposed to the cooperative strategy was higher than the mean score of 52.73 and standard deviation of 13.84 for students exposed to laboratory method, and this was in turn higher than the mean score of 40.82 and standard deviation of 12.74 for students who were exposed to the lecture method. This mean scores are differing with the standard deviation scores which revealed the existence of difference in the performance of the three groups. This difference could be regarded as the improvement achieved or the degree of enhancement of the students' academic performance that could be attributed to the use of the cooperative and laboratory learning strategies adopted in the study. The result shows that students taught the concept of acid and base using cooperative strategy have a better mean score than those taught the same concept using laboratory method. The mean score of students taught the concept of acid and base using cooperative strategy was on the other hand better than the mean score of students taught the same concept with conventional (lecture) method of teaching in secondary schools in Jigawa State. The

significance of this variability in the academic performance between the three groups is tested in the corresponding hypothesis.

4.3 Testing of Hypotheses

Six hypotheses were formulated for testing in this study. Four hypotheses were tested using independent sample t-test while two hypotheses were tested using Analysis of Variance (ANOVA) at 0.05 alpha level of significance, as follows:

Null Hypothesis One: There is no significant difference in the performance mean score of students taught chemistry using cooperative learning strategy and those taught with the conventional lecture method.

To analyze this hypothesis, the post-test scores of students in the experimental group 1 (cooperative) and control group (conventional method) were tested using t-test independent sample as shown in Table 11.

Table 11: Independent sample t-test for null hypothesis one

Strategy	N	Mean	Std. Deviation	Std. Error Mean	t	Df	Sig. (2-tailed)	Decision
Cooperative	88	57.63	13.145	1.401	6.27	199	.000	Rejected
Conventional	113	45.73	13.492	1.269				

The result of the t-test in Table 11 revealed that the mean score of 57.63 and the standard deviation of 13.15 for students taught chemistry using cooperative learning strategy was higher than the mean scores of 45.73 and standard deviation of 13.49 for students who were exposed to conventional method. The observed level of significance for the test was 0.000 and this is lower than the significant level set at $P \leq 0.05$ which is an indication that there is a significant difference in academic performance between the two groups. The null hypothesis which states that there is no significant difference in the performance mean score of students taught chemistry using cooperative learning strategy and their counterparts taught with the

conventional lecture method is thus rejected. This infers that students taught chemistry using cooperative learning strategy performed significantly better than those taught using conventional lecture method.

Null Hypothesis Two: There is no significant difference in retention ability of students taught chemistry with cooperative learning strategy and those taught with conventional method.

The retention test scores of students in the experimental group 1 (cooperative) and control group (conventional method) were tested using t-test independent sample to determine the retention ability of students in chemistry as shown in Table 12.

Table 12: Independent sample t-test for null hypothesis Two

Strategy	N	Mean	Std. Deviation	Std. Error Mean	t	Df	Sig. (2-tailed)	Decision
Cooperative	88	60.17	13.933	1.485	10.250	199	.000	Rejected
Conventional	113	40.82	12.744	1.199				

The independent t-test result in Table 12 revealed that the mean score of 60.17 and the standard deviation of 13.93 for students taught chemistry using cooperative learning strategy was higher than the mean scores of 40.82 and standard deviation of 12.74 for students who were exposed to conventional method. The observed level of significance for the test was 0.000 and this is lower than the significant level set at $P \leq 0.05$ which is an indication that there is a significant difference in academic retention ability between the two groups. The null hypothesis which states that there is no significant difference in retention ability of students taught chemistry with cooperative learning strategy and those taught withconventional lecture method is thus rejected, meaning that 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.

Null Hypothesis Three: There is no significant difference in the performance mean scores of students taught chemistry using laboratory method and their counterparts taught with the conventional lecture method.

To analyze this hypothesis, the post-test scores of students in the experimental group 2 (laboratory) and control group (conventional method) were tested using t-test independent sample as shown in Table 13.

Table 13: Independent sample t-test for null hypothesis Three

Strategy	N	Mean	Std. Deviation	Std. Error Mean	t	Df	Sig. (2-tailed)	Decision
Laboratory	103	63.466	14.320	1.411	8.568	214	.000	Rejected
Conventional	113	46.743	14.332	1.348				

The result of the t-test in Table 13 revealed that the mean score of 63.45 and the standard deviation of 14.32 for students taught chemistry using laboratory method was higher than the mean scores of 46.74 and standard deviation of 14.33 for students who were exposed to conventional method. The observed level of significance for the test was 0.000 and this is lower than the significant level set at $P \leq 0.05$ which is an indication that there is a significant difference in academic performance between the two groups. The null hypothesis which states there is no significant difference in the performance mean scores of students taught chemistry using laboratory method and their counterparts taught with the conventional lecture methodis thus rejected. This means that laboratory method significantly enhanced students' academic performance in chemistry compared to conventional method in secondary school in Jigawa State.

Null Hypothesis Four: There is no significant difference in retention ability of students taught chemistry with laboratory method and those taught with conventional lecture method.

The retention test scores of students in the experimental group 2 (laboratory) and control group (conventional method) were tested using t-test independent sample to determine the retention ability of students in chemistry as shown in Table 14.

Table 14: Independent sample t-test for null hypothesis Four

Strategy	N	Mean	Std. Deviation	Std. Error Mean	t	Df	Sig. (2-tailed)	Decision
Laboratory	103	52.728	13.844	1.364	6.58	214	.000	Rejected
Conventional	113	40.823	12.744	1.199				

The independent t-test result in Table 14 revealed that the mean score of 52.73 and the standard deviation of 13.84 for students taught chemistry using laboratory method was higher than the mean scores of 40.82 and standard deviation of 12.74 for students who were exposed to conventional method. The observed level of significance for the test was 0.000 and this is lower than the significant level set at $P \leq 0.05$ which is an indication that there is a significant difference in academic retention ability between the two groups. The null hypothesis which states that there is no significant difference in retention ability of students taught chemistry with laboratory method and those taught with conventional lecture method is thus rejected. This means that laboratory method significantly enhanced students' academic retention ability in chemistry compared to conventional method in secondary school in Jigawa State.

Null Hypothesis Five: There is no significant difference in performance of students taught chemistry with cooperative strategy, laboratory method and conventional lecture method.

To analyze this hypothesis, the post-test scores of students in the experimental group 1 (cooperative), experimental group 2 (laboratory) and control group (conventional method) were tested using t-test analysis of variance (ANOVA) as shown in Table 15.

Table 15: Analysis of Variance (ANOVA) Result for Hypothesis Five

Groups	Sum of Squares	Df	Mean Square	F	Sig.	Decision
Between Groups	17698.298	2	8849.149	47.280	.000	Rejected
Within Groups	56336.752	301	187.165			
Total	74035.049	303				

Analysis from Table 15, indicated that the calculated F – value is 47.280 with the degree of freedom Between Groups and Within Groups 2 and 301, degree of freedom total is 303. This value is greater than F – critical at alpha = 0.05 level of significance. It shows that there is significant difference between the post test scores of the experimental groups that is cooperative strategy, laboratory and control group (lecture method). Therefore, the hypothesis is rejected. Moreover, it was observed that the P – value is 0.00 which indicates a significant difference in the performance of the three groups at alpha value of 0.05 with total degree of freedom df = 303. This means that there is significant difference between the post test scores of the experimental and the control groups which is in favour of the experimental groups that is cooperative and laboratory method. Thus, the hypothesis is rejected. This implies that the experimental groups taught the concepts of acid and base using cooperative and laboratory method performed significantly better than the control group taught the same concepts using lecture method.

As the null hypothesis is rejected, therefore the need to conduct a post hoc test in order to determine the direction of difference among the means performance scores of the groups as shown in table 16.

Table 16: Scheffe Multiple Comparisons Test Result for Performance

(I) Treatment groups	(J) Treatment groups	Mean Difference (I-J)	Std. Error	Sig.
Cooperative	Laboratory	-5.84102*	1.98595	.014
	Lecture	11.89934*	1.94505	.000
Laboratory	Cooperative	5.84102*	1.98595	.014
	Lecture	17.74036*	1.86372	.000
Lecture	Cooperative	-11.89934*	1.94505	.000
	Laboratory	-17.74036*	1.86372	.000

From the post hoc test in Table 16, the result shows that laboratory method scored significantly higher than cooperative strategy at P<0.014.The cooperative strategy group scored significantly higher than the lecture method group at P<0.000. Therefore, the research hypothesis is rejected. The three teaching strategies were significantly different in their effects on students' performance in learning chemistry concepts. In respect to learning of chemistry concepts, laboratory method was more effective than cooperative strategy, while cooperative strategy was more effective than lecture method.

Null Hypothesis Six: There is no significant difference in retention ability between students taught with cooperative strategy, laboratory method and lecture method.

To analyze this hypothesis, the post-test scores of students in the experimental group 1 (cooperative), experimental group 2 (laboratory) and control group (lecture method) were tested using t-test analysis of variance (ANOVA) as shown in Table 17.

Table 17: Analysis of Variance (ANOVA) Result for Hypothesis Six

Groups	Sum of Squares	Df	Mean Square	F	Sig.	Decision
Between Groups	19322.152	2	9661.076	53.235	.000	Rejected
Within Groups	54625.292	301	181.479			
Total	73947.444	303				

The result from Table 17, shows that the calculated F – value is 53.235 with the degree of freedom Between Groups and Within Groups was found to be 2 and 301, and a total of 303. This value is greater than F – critical at alpha = 0.05 level of significance. It shows that there is significant difference between the retention test scores of the experimental groups that is cooperative strategy, laboratory method and lecture method. Therefore, the hypothesis is rejected. It was also observed that the P – value is 0.00 which indicates a significant difference in the retention ability of the three groups at alpha value of 0.05 with total degree of freedom df = 303. This means that there is significant difference between the retention test scores of the experimental and the control groups which is in favour of the experimental groups that is cooperative and laboratory method. Thus, the hypothesis is rejected. This implies that the experimental groups taught chemistry concepts using cooperative and laboratory method retained significantly higher than the control group taught the same concepts using lecture method.

As the null hypothesis is rejected, therefore the need to conduct a post hoc test, in order to determine the direction of difference among the means performance scores of the groups as shown in table 18.

Table 18: Scheffe Multiple Comparisons Test Result for Retention

(I) Treatment groups	(J) Treatment groups	Mean Difference (I-J)	Std. Error	Sig.
Cooperative	Laboratory	7.44230*	1.95556	.001
	Lecture	19.34745*	1.91527	.000
Laboratory	Cooperative	-7.44230*	1.95556	.001
	Lecture	11.90515*	1.83520	.000
Lecture	Cooperative	-19.34745*	1.91527	.000
	Laboratory	-11.90515*	1.83520	.000

From the post hoc test in Table 18, the result shows that cooperative learning strategy scored significantly higher than laboratory method at P<0.001.The laboratory-based group scored significantly higher than the lecture method group at P<0.000. Therefore the research hypothesis is rejected. The three teaching strategies were significantly different in their effects on students' retention ability in learning chemistry concepts. On students' retention ability in learning chemistry concepts, cooperative learning strategy was more effective than laboratory method, while laboratory method was more effective than lecture method.

4.4 Summary of Major Findings

The major findings from the analysis of the data and test of the study's hypotheses are summarized as follows:

1. Students taught concept of chemistry using cooperative learning strategy performed significantly better than those taught with the conventional method in secondary schools in Jigawa State (P-value of 0.000 < 0.05).
2. The difference in retention ability of students exposed to Cooperative learning strategy and those exposed to conventional method was found to be statistically

significant among chemistry secondary school students in Jigawa State (P-value of 0.000 < 0.005).

3. The use of laboratory method has significant effect on the academic performance of chemistry students compared to those exposed to conventional method in secondary schools in Jigawa State (P-value of 0.000 < 0.05).
4. The difference in retention ability of students exposed to laboratory method and those exposed to conventional method was found to be statistically significant among chemistry secondary school students in Jigawa State (P-value of 0.000 < 0.05).
5. There was difference between the performance of students taught concept of chemistry using cooperative learning strategy, laboratory method and conventional method in secondary schools in Jigawa State (P-value of 0.000 < 0.05).
6. There was difference in retention ability of students taught concept of chemistry using cooperative learning strategy, laboratory method and conventional method in secondary schools in Jigawa State (P-value of 0.000 < 0.05).

4.4 Discussion of Findings

This study investigates theeffects of cooperative and laboratory method on performance and retention of students in chemistry in secondary school in Jigawa state, Nigeria. At descriptive and inferential levels, six research questions were answered and six hypotheses were analyzed and the major findings were discussed as follows: Table 11 (Hypothesis one) revealed that the mean score of 57.63 and the standard deviation of 13.15 for students taught chemistry using cooperative learning strategy was higher than the mean scores of 45.73 and standard deviation of 13.49 for students who were exposed to conventional method. The observed level of significance for the test was 0.000 and this is lower than the significant level set at $P \leq 0.05$. This means that cooperative learning strategy significantly enhanced students' academic performance in chemistry among secondary school students in Jigawa

State. Similarly, Table 5 (Research question one), shows that the mean academic performance score of 57.63 and standard deviation of 13.14 for students who were exposed to the cooperative learning strategy was higher than the mean score of 45.73 and standard deviation of 13.49 for students who were exposed to the lecture method. The result indicated that students taught the concept of acid and base using cooperative learning strategy have a better mean score than those taught the same concept using conventional (lecture) method of teaching in secondary schools in Jigawa State.

The finding agreed with findings of Isah (2015), Tunga (2015), and Yusuf (2011) who found that students taught with cooperative learning strategy performed significantly higher than students taught with conventional lecture method in the cause of teaching and learning at various education levels.

The analysis in Table 12 (hypothesis two) revealed that the mean score of 60.17 and the standard deviation of 13.93 for students taught chemistry using cooperative learning strategy was higher than the mean scores of 40.82 and standard deviation of 12.74 for students who were exposed to conventional method. The observed level of significance for the test was 0.000 and this is lower than the significant level set at $P \leq 0.05$. This result indicated that cooperative learning strategy significantly enhanced students' academic retention ability in chemistry among secondary school students in Jigawa State. Also the result from research question two on Table 6 revealed that the mean academic retention scores of the two groups that is Cooperative and Lecture methods were 60.17 and 40.82 with standard deviation of 13.93 and 12.74. This mean scores are differing with the standard deviation scores which revealed the existence of difference in the performance of the two groups. It's clear from the figures above that the cooperative strategy performed better than the lecture method. The result indicated that students taught the concept of acid and base using cooperative learning strategy have a better mean score than those taught the same concept using conventional

(lecture) method of teaching in secondary schools in Jigawa State. The result agreed with that of Omwirhiren (2015) and Isah (2015) who found that students taught with cooperative learning strategy retained concept of chemistry significantly higher than students taught with conventional method.

Findings in Table 13 (Hypothesis three), revealed that the mean score of 63.45 and the standard deviation of 14.32 for students taught chemistry using laboratory method was higher than the mean scores of 46.74 and standard deviation of 14.33 for students who were exposed to conventional method. The observed level of significance for the test was 0.000 and this is lower than the significant level set at $P \leq 0.05$. This indicated that laboratory method significantly enhanced students' academic performance in chemistry among secondary school students in Jigawa State. Response to research question three on table 7, shows that the mean academic performance score of 63.47 and standard deviation of 14.32 for students who were exposed to the Laboratory method was higher than the mean score of 46.74 and standard deviation of 14.33 for students who were exposed to the lecture method. The result shows that students taught the concept of acid and base using laboratory method have a better mean score than those taught the same concept using conventional (lecture) method of teaching in secondary schools in Jigawa State.

The above finding agreed with that of Leman and Burcin (2010) who stressed that students who were taught with laboratory method has significantly higher scores than those taught using lecture. Similarly, this finding is in line with that of Ogundiwin, Asaaju, Adegoke and Ojo (2015) who reported that those students taught using laboratory method performed significantly better than those taught using lecture method.

Result in Table 14 (Hypothesis four) revealed that the mean score of 52.73 and the standard deviation of 13.84 for students taught chemistry using laboratory method was higher than the mean scores of 40.82 and standard deviation of 12.74 for students who were exposed to

conventional method. The observed level of significance for the test was 0.000 and this is lower than the significant level set at $P \leq 0.05$. This indicates that laboratory Method significantly enhanced students' academic retention ability in chemistry among secondary school students in Jigawa State. In response to research question four on table 8, the result revealed that the mean academic retention scores of the two groups that is laboratory method and Lecture method were 52.73 and 40.82 with standard deviation of 13.84 and 12.74. The result indicated that students taught the concept of acid and base using laboratory method have a better mean score in academic retention ability than those taught the same concept using conventional (lecture) method of teaching in secondary schools in Jigawa State.

This tallied with the finding of Alake (2015) who revealed that students exposed to laboratory method achieved and retained the learnt concept more than those taught using conventional lecture method. Similar to this finding, is the findings of Ogbeba and Adagbaby (2013) who found out that students taught with laboratory method retained academic concepts better.

Analysis from Table 15 (hypothesis five), indicated that the calculated F – value is 47.280 with the degree of freedom Between Groups and Within Groups 2 and 301, degree of freedom total is 303. This value is greater than F – critical at alpha = 0.05 level of significance. It shows that there is significant difference between the post test scores of the experimental groups that is cooperative strategy, laboratory and control group (lecture method). Moreover, it was observed that the P – value is 0.00 which indicates a significant difference in the performance of the three groups at alpha value of 0.05 with total degree of freedom df = 303. This means that there is significant difference between the post test scores of the experimental and the control groups which is in favour of the experimental groups that is cooperative strategy and laboratory method. This implies that the experimental groups taught the concepts of acid and base using cooperative strategy and laboratory method performed significantly higher than the control group taught the same concepts using lecture

method in secondary schools in Jigawa State. Response to research question five in Table 9 shows that the mean academic performance score of 63.47 and standard deviation of 14.32 for students who were exposed to the Laboratory method was higher than the mean score of 57.63 and standard deviation of 13.14 for students exposed to cooperative strategy, and this was in turn higher than the mean score of 45.73 and standard deviation of 13.49 for students who were exposed to the lecture method. The result indicated that students taught the concept of acid and base using laboratory method have a better mean score than those taught the same concept using cooperative strategy. The mean score of students taught the concept of acid and base using cooperative strategy was in turn better than the mean score of students taught the same concept with conventional method of teaching in secondary schools in Jigawa State.

Also the post hoc test result in table 16, revealed that laboratory method scored significantly higher than cooperative strategy at $P<0.014$. The cooperative strategy group scored significantly higher than the lecture method group at $P<0.000$. The three teaching strategies were significantly different in their effects on students' performance in learning chemistry concepts. In respect to learning of chemistry concepts, laboratory method was more effective than cooperative strategy, while cooperative strategy was more effective than lecture method. This indicated that laboratory method is more effective in enhancing students' performance in chemistry among secondary students in Jigawa State. The finding agreed with findings of Sheikhi, Zainailipoor and Jamri (2012), Halliru (2015), Abdullahi (2014) and Olorukooba (2001) who found out that the use of cooperative learning strategy had significant effect on students' academic performance.

The result from Table 17 (Hypothesis six), shows that the calculated F – value is 53.235 with the degree of freedom Between Groups and Within Groups was found to be 2 and 301, and a total of 303. This value is greater than F – critical at alpha = 0.05 level of significance. It shows that there is significant difference between the retention test scores of the experimental

groups that is cooperative strategy, laboratory method and lecture method. It was also observed that the P – value is 0.00 which indicates a significant difference in the retention ability of the three groups at alpha value of 0.05 with total degree of freedom df = 303. This means that there is significant difference between the retention test scores of the experimental and the control groups which is in favour of the experimental groups that is cooperative strategy and laboratory method. This implies that the experimental groups taught chemistry concepts using cooperative and laboratory method retained significantly higher than the control group taught the same concepts using lecture method. Response to research question six in Table 10 revealed that the mean academic performance score of 60.17 and standard deviation of 13.93 for students who were exposed to the cooperative strategy was higher than the mean score of 52.73 and standard deviation of 13.84 for students exposed to laboratory method, and this was in turn higher than the mean score of 40.82 and standard deviation of 12.74 for students who were exposed to the lecture method. This mean scores are differing with the standard deviation scores which revealed the existence of difference in the performance of the three groups. The result shows that students taught the concept of acid and base using cooperative strategy have a better mean score than those taught the same concept using laboratory method.

The mean score of students taught the concept of acid and base using cooperative strategy was on the other hand better than the mean score of students taught the same concept with conventional method of teaching in secondary schools in Jigawa State. Moreover, the post hoc test result in table18, shows that cooperative learning strategy scored significantly higher than laboratory method at $P<0.001$.The laboratory-based group scored significantly higher than the lecture method group at $P<0.000$. The three teaching strategies were significantly different in their effects on students' retention ability in learning chemistry concepts. On students' retention ability in learning chemistry concepts, cooperative learning strategy was

more effective than laboratory method, while laboratory method was more effective than lecture method. This indicated that cooperative learning strategy is more effective in enhancing students' retention ability in chemistry among secondary students in Jigawa State. The finding agreed with findings of Omwirhiren (2015), Goje (2014) and that of Tarhan andSesen (2010) who found out that the use of laboratory method had significant effect on students' academic retention ability. Therefore, students taught using cooperative learning strategy have the ability of recalling chemistry concepts than those taught with laboratory and lecture methods.

CHAPTER FIVE
SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The study examined theeffects of cooperative and laboratory method on performance and retention of students in chemistry in secondary school in Jigawa state, Nigeria. The study was carried out with six guided objectives which are to; find out the effect of cooperative learning strategy on academic performance of students in chemistry when compared to conventional method; ascertain the effect of cooperative learning strategy on students' retention ability in chemistry; investigate the effect of laboratory method on students' performance in chemistry when compared to conventional method; determine the effect of laboratory method on students' retention ability in chemistry; compare students' performance taught with cooperative strategy, laboratory method and conventional method; and compare the retention ability of students taught chemistry with cooperative strategy, laboratory Method and lecture method. 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 better than those taught the same concept using conventional (lecture) method of teaching in secondary schools in Jigawa State; Significant difference exists between the performance of students taught chemistry concept using laboratory method and those using lecture method in secondary schools in Jigawa State; Students taught the concept of chemistry using cooperative learning strategy retained chemistry concepts significantly better than those taught using laboratory method and lecture method in Jigawa State secondary schools among other findings. Recommendations and contribution to knowledge were made in line with the findings of the study.

5.2 Conclusion

Based on the findings of this research, the following conclusions were made: students taught chemistry using cooperative learning strategy performed significantly better than those taught using conventional lecture method in secondary schools in Jigawa State; 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; laboratory method significantly enhanced students' academic performance in chemistry compared to conventional method in secondary school in Jigawa State; laboratory method significantly enhanced students' academic retention ability in chemistry compared to conventional method in secondary school in Jigawa State; students taught the concepts of chemistry using cooperative and laboratory method performed significantly better than those taught the same concepts using lecture method and those taught with laboratory method performed better than those taught using cooperative learning strategy in secondary schools in Jigawa State; and students taught the concept of chemistry using cooperative learning strategy have a better academic retention ability than those taught using laboratory method,

while those taught using laboratory method retained chemistry concepts more than those taught with conventional lecture method in secondary schools in Jigawa State.

5.3 Recommendations

Considering the findings of this study, the researcher recommended as follows:

1. chemistry teachers should use cooperative learning strategy because of its positive effect in enhancing students' academic performance;
2. 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;
3. teachers should use laboratory method as a common strategy in teaching chemistry because of its ability in enhancing students' performance in chemistry;
4. curriculum planners, school managers and ministry of education at both state and federal level should incorporate and support the use of laboratory in teaching chemistry in secondary schools;
5. government, communities, and non-governmental agencies should encourage and support practical work in chemistry as it improves students' performance; and teachers should be supported to go for professional development training in order to acquire the skills for making students to work together in cooperative learning strategy as it enhance students' academic retention ability in chemistry. Furthermore, the use of cooperative learning strategy in this study gave the researcher an idea on how to incorporate teaching methods like excursion and field-trip into cooperative strategy which the researcher called 'Field-jigsaw Cooperative Model' (SeeAppendix J).

5.4 Contributions to Knowledge

Based on the findings of this research, the study revealed that;

1. students taught chemistry using cooperative learning strategy performed significantly better than those taught using conventional lecture method in secondary schools in Jigawa State;
2. teaching students chemistry using cooperative learning strategy significantly enhanced their academic retention ability compared to those taught using lecture method in secondary schools in Jigawa State;
3. students taught chemistry using laboratory method significantly performed better than those taught conventional method in secondary school in Jigawa State;
4. laboratory method significantly enhanced students' academic retention ability in chemistry compared to conventional method in secondary school in Jigawa State;
5. students taught concept of chemistry using laboratory method performed better than those taught using cooperative learning strategy in secondary schools in Jigawa State; and
6. students taught the concept of chemistry using cooperative learning strategy have a better academic retention ability than those taught using laboratory method in secondary schools in Jigawa State.

5.5 Suggestions for Further Studies

The researcher is of the opinion that further studies be carried out to cover other concepts in the following areas;

1. effects of cooperative and laboratory method on performance and retention of students in Biology in Secondary Schools in Jigawa state;
2. effects of cooperative learning strategy in integrated science among junior secondary schools students in Jigawa state;

3. effects of cooperative and laboratory method on performance and retention of students in physics in secondary schools in Jigawa state;
4. effects of cooperative and laboratory method on performance, retention and attitudes of students in chemistry in secondary schools in Jigawa state.

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APPENDIX A

Acid Base Performance Test (ABPT)

INSTRUCTION: This test consist of 50 objective items. Each question is followed by 4 alternative responses lettered a-d. Answer all questions. You are expected to tick or circle the correct responses for each question. Each question carries one mark.

TIME: 90 minutes

1. An acid is a substance which in the presence of water produces:

   a. Hydroxonium ions b. Oxygen c. Salts d. Hydrogen gas

2. Which are the correct products for these reactants HCl + NaOH

   a. HOH + ClNa

   b. H_3O + NaCl2

   c. NaCl + H_2O

   d. NaOH + Cl

3. Which one of the following is the correct chemical formula for hydrochloric acid:

   a.NaCl b. H_2SO_4 c. HCl d. NO_3

4. Which one of the following substances is NOT a base:

   a. H_2SO_4 b. NH_3 c. KOH d. $Ca(OH)_2$

5. A solution which is at equilibrium with its solute is said to be

   a. Neutral b. Basic c. Acidic d. Saturated

6. All alkalis changes litmus paper from:

   a. Orange to red b. Red to blue c. Blue to green d. Blue to red

7. When an acid reacts with an alkali to form salt and water, only the reaction is termed:

   a. Hydration b. Neutralization c. Direct combination d. Hydrolysis

8. Why are indicators used in acid-base titration?

a. So as to determine the exact volume of acid needed to neutralize a given volume of base and vice-versa:

b. So as to determine the pH of both the acid and base

c. Because an acid requires an indicator before it can react with a base

d. Because indicators are acids which first have to be neutralized by the base

9. All of the following are properties of acid EXCEPT:

a. Ability to produce hydroxonium ions in aqueous solution

b. Ability to neutralize a base

c. Sour taste d. Soapy feel

10. Which of the following solutions is the most acidic

a. 6 b. 4 c. 3 d. 9

11. The pH of four solutions W, X, Y, Z are 4, 6, 8, 10 respectively, therefore:

a. None of these solution is acidic

b. The pH of Y can be acidic by adding water

c. Z is the most acidic

d. W is acidic

12. Which of the following elements forms more than one acidic oxide?

a. Hydrogen b. Sulphur c. Aluminum d. Iron

13. In neutralization reaction the apparatus used for sucking base is:

a. Pipette, c. Conical flask c. Burette d. Funnel

14. The brownish yellow colour of concentrated trioxonitrate (v) acid is due to the presence of

a. Nitrogen b. Iron (iii) salts c. Excess air d. Nitrogen (iv) oxide

15. Which of the following chemical reactions represents an acid-base reaction?

a. $HBr + KOH \rightarrow KBr + H_2O$

b. $ZnCl_2 + MgSO_4 \rightarrow ZnSO_4 + MgCl$

c. $H_2SO_4 + CaCl_2 \rightarrow CaSO_4 + HCl$

d. $NH_4OH + KCl \rightarrow KOH + NH_4Cl$

16. Which of the following is NOT a characteristics property of strong acid:

a. It contains a small amount of water
b. It reacts with metals to give hydrogen
c. It turns red litmus paper blue
d. It ionizes almost completely in water

17. The number of replaceable hydrogen atoms is one molecule of an acid indicate its:

a. Basicity b. Acidity c. Alkalinity d. Reactivity

18. Which of the following statements is CORRECT

a. 1 mole of Sodium metal contains the same number of particles as 1 mole of sodium chloride
b. 1 mole of sodium ions contains the same number of particles as 1 mole of sodium chloride
c. 1 mole of sodium chloride contains the same number of particles as 1 mole of sodium chloride
d. 1 mole of sodium chloride contains exactly half of the number of particles in 1 mole of calcium chloride

19. $100cm^3$ of 0.2m K_2SO_4 is added to $100cm^3$ of water and mixed thoroughly. The molarity of K_2SO_4 ion, in the resulting solution is:

a. 0.09 b. 0.10 c. 0.15

b. 0.40

20. Which one of the following solutions contains the most sodium ions?

a. 0.1 liters of 0.011m Na_3PO_4

b. 0.1 liters of 2.0m NaCl

c. 0.2 liters of 0.5m Na_3CO_4

d. 0.5 liters of o.5m NaOH

21. The number of species in one mole of a substance is the:

a. Concentration b. Atomicity c. Oxidation d. Quantum Number

22. What is the concentration of a solution which contains 2.0g of sodium hydroxide per $250cm^3$

a. 0.02 $Moldm^{-3}$ b. 0.05 $Moldm^{-3}$ c. 0.20 $Moldm^{-3}$ d. 2.00 $Moldm^{-3}$

23. A solution of pH 7 is:

a. Acidic b. Neutral c. Basic d. Dilute

24. Excess acidity caused by acid rain can be neutralized by adding:

a. More fertilizers

b. By removing acidified soil

c. By adding lime

d. By adding P_2O_5

25. The solution with the lowest pH value is:

a. 5ml of $\frac{m}{10}$ HCl

b. 10ml of $\frac{m}{10}$ HCl

c. 15ml of $\frac{m}{5}$ HCl

d. 20ml of $\frac{m}{8}$ HCl

26. For the reaction $MgO + 2HCl \rightarrow ? + H_2O$, what is missing?

a. Mg_2Cl b. MgCl c.$MgCl_2$ d. 2MgCl

27. 0.2 Mole of hydrogen chloride was dissolved in distilled water and the volume made up to 0.50 moles per dm^{-3}. If 15.00cm^3 of the solution requires 12.50cm^3 of aqueous sodium trioxocarbonate (iv) of neutralization, calculate the concentration of the alkaline solution

a. 0.30 mol dm^{-3} b. 0.40 mol dm^{-3}

c. 0.50 mol dm^{-3} d. 0.60 mol dm^{-3}

28. What volumes of 0.05m sodium trioxocarbonate (iv) solution (in units of cm^3) will be required to neutralize completely 30cm^3 of 0.1m hydrochloric acid solution? The equation for the reaction is: $NaCO_3 + 2HCl – 2NaCl + H_2O + CO_2$

a. 15.0 b. 30.0 c. 45.0 d. 60.0

29. How many moles of oxygen atoms are present in 4.0g of gas?

a. 0.25mol b. 0.50mol c.0.76mol d.1.00mol

30. How many atoms are there in 0.3 moles in an element?

a. 2.0×10^{22} b. 1.8×10^{22} c. 1.0×10^{22} d. 3.0×10^{22}

31. All are acids EXCEPT

a. HCL b. H_2SO_4 c. NaOH d. HNO_3

32. $Pb(NO_3) + 2KI – PbI_2 + 2KNO_3$

From the equation above, hoe many moles of KI will be required to 3 moles of lead II iodine with excess Pb $(NO_3)_2$ solutions?

a. 2 mol b. 3 mol c. 4 mol d. 6 mol

33. What mass of tetraoxosulphate (iv) acid is contained in 400$cm^3$of 0.05cm solutions?

a. 0.5m(g) b. 9.8 (g) c. 14.7(g) d. 49.0(g)

(H=1.0, O = 16.0, S = $32.1_{(g)}$)

34. Which of the following is simple neutral acid?

a. Lactic acid b. Citric acid c. Nitric acid d. Tartaric acid

35. The basicity of ethanoic is

a. 1 b. 2 c. 4 d. 5

36. Which of the following species is always present in acidified water?

a. NH_4^+ b. O^{2-} c. H_3O^+ d. HNO_3

37. What is the molarity of an HCl solution if 50.0 mL is neutralized in a titration by 40.0 mL of 0.400 M NaOH?

a. 0.280 M b. 0.500 c. 0.320 M d.0.200 M

38. Which of the following pieces of equipment should be rinsed with the reagent they are to contain rather than water beginning a titration? X = Burette, Y = Conical flask

a. X only b. Y only c. X and 2 only d. X and Y only

39. What quantity of electrons (in mole) is lost when one mole of ion II ions is oxidized to ion III ions:

a. 5 mole b. 1 mole c. 3 mole d. 2 mol

40. Which of the following is largely present in sour milk?

a. Tartaric acid b. Lactic acid c. Citric acid c. Methanoic acid

41. Which of the following ionic species exist in a neutralization reaction?

a. HCl^-

b. H_3O^+

c. H_2O

d. H^+

42. What kinds of beakers should be used to store acidic solutions such as lemon juice and vinegar?

a. Beakers made of glass

b. Beakers made of iron

c. Beakers made of zinc

d. Beakers made of aluminum

43. Which one of the following statements does define the concept of BASE the most correctly?

a. If a species contains OH in its formula and can give it to water, it is a base

b. Bases are the matters that are composed of acids

c. If a species increases the amount of OH – ion when it dissolves in water, it is a base

d. Species that can be used as household chemicals are bases

44. Which one of the following reactions is a neutralization reaction?

a. $KOH + HCI \rightarrow NaCI + H_2O$

b. $CO + ½\ O_2 \rightarrow CO_2$

c. $Ca + 2HCI \rightarrow CaCI_2 + H_2$

d. $NaOH \rightarrow Na^+ + OH^-$

45. In an aqueous solution, it is determined that the amount of H^+ions is less than the amount of OH^-ions. Which one(s) of the following statements is/are correct for this solution?

I. It is basic II. It is acidic

III. It conducts electricity IV. It turns blue litmus red

a. I and III b. II and IV c. I, III and IV d. II, III and IV

46.Which one of the following statements is the most correct regarding acids?

a. All acids are poisonous

b. All strong acids cannot dissociate in water

c. An aqueous solution of acid can highly conduct electricity

d. A strong acid can react with metal to produce more bubbles than a weak acid

47. Which one(s) of the following statements about the pH values of acidic or basic matters used in daily life is/are wrong? Matter pH value

I. Vinegar 3 II. Bread 9 III. Apple 4 IV. Milk 12

a. II and IV b. II and IIII c. I, II and III d. II, III and IV

48. Which one of the following statements is the most correct regarding bases:

a. Base is highly soluble in water

b. Compounds that do not contain OH can also be basic

c. All bases are corrosive

d. Aqueous solutions of bases cannot conduct electricity

49. Which one of the following statements is absolutely correct for a solution if the pH value of it is less than 7?

a. It is a salt solution

b. It is a basic solution

c. It is an acidic solution

d. It is a neutral solution

50. Which of the following is a weak base?

(a) NaOH (b) KOH (c) NH_4OH (d) NaCl

APPENDIX B

MARKING SCHEME

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

24. C

25. A

26. C

27. D

28. A

29. A

30. B

APPENDIX C

LESSON PLAN FOR EXPERIMENTAL GROUP ONE (COOPERATIVE)

LESSON ONE

Topic: The Concepts of acid.

Week: One (1)

Level: SS II

Length of class period: 90 min.

Main activity: Defining of acid, physical and chemical properties of acids, identification of acids, acids in everyday substances and types of acids

Model of Teaching: Cooperative learning (jigsaw) model

Learning Objective:

Cognitive:

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

- Define acids.
- State physical and chemical properties of acids.
- Mention ways in which acids can be identify scientifically.
- Recognize acids in everyday substances.
- classify acids.

Affective:

The students will learn how to work cooperatively in group.

Psychomotor:

Students moves from Jigsaw main groups to Expert groups and back to Jigsaw groups and interact/communicate with one another.

Materials:

- Worksheet for all students: A4 papers and writing materials

- Copies of study notes to all expert group students on:

1. Definitions of acid
2. Physical properties of acids
3. Chemical properties of acids.
4. Ways in which acids can be identify scientifically
5. Acids in everyday substances
6. Classification of acids

Activity outline for expert groups (EGR)

EGR 1. Members of this expert group are to discuss on the following specific areas:

a. Bronsted Lowry definition of acid
b. Arrhenius definition of acid
c. Examples of common acids with their chemical formula.

EGR 2. Members of this group are to discuss on the following specific areas:

1. Physical properties of acids

EGR 3. Members of this group are to discuss on the following specific areas:

1. Chemical properties of acids

EGR 4. Members of this group are to discuss on the following specific areas:

1. Identification of acid using scientific approaches

EGR 5. Members of this group are to discuss on the following specific areas:

1. Acids in everyday substances
2. Classification of acids

Roles/Responsibilities:

Leader:Collect group folders containing materials.

Distribute materials to group members

Return materials to folders then to teacher

Reader: Reads the group task to the group

Timer: Keeps truck of the time

Makes sure everyone contributes to answer the questions within the stipulated time

Organizer: Encourages group members

Decides on the order for the members to read the task

Presentation:

Teacher Activity

Step 1. The teacher will inform the students that they are going to learn the concept of acid using a cooperative learning strategy where all of them will work cooperatively together, and that the success of the group depends on the success of the individual member of the group. Therefore they are expected to work as a team, whereby every member of the group is working towards the success of his/her group.

Step 2. The teacher will then group the students into the main cooperative learning group comprising of five to six students per group. Making sure that the groups are heterogeneous in nature.

Step 3. The teacher will then explain what the students are expected to be doing from the beginning to the end of the lesson including the social skills they are expected to learn and apply in their interaction with one another during their group work. These skills may include using group names, expert names, timing, asking questions and the rest.

Students' Activity:

Group Tasks

1. Collect and distribute the materials (A4 paper/writing materials and study notes).
2. Take turn reading and highlighting the important information.

3. As a group, decide what information should be highlighted.
4. As a group, answer the questions.
5. Each member must fill in their activity sheet.
6. Return the materials and group member activity sheet.

Specific procedure:

To begin the lesson, the teacher will give each group name written on a card. Each individual member of the group will then be given specific task to work/study. His expert name attached to the study note of the task given to him/her will be provided to him/her. Each expert will be asked to study his/her task for some time. No student in the same group will be allowed to see the task given to his fellow group member. In case of a task which is too demanding, a helper can be attached to the student who will represent the main group in the expert group. Students studying the same task from each group will then be asked to form expert groups where they will study collectively the task and record useful information on the worksheet earlier provided for the purpose of feed back to his/her main (cooperative) group.

Members of the expert groups will after some time be asked to break and go back to their main cooperative groups where each expert will explain his/her task to the remaining members of his group. Other members of the group will be encouraged to ask questions and clarification from the expert. As the group discussion is on, members of the group assigned to perform certain role like the time keeper, questioner, reader, reminder, and so forth will be doing their job while the teacher goes round to support them.

Evaluation:

Each group will answer the following questions at the end of the group discussion to evaluate learning outcome:

1. Define acids.
2. State the physical and chemical properties of acids.
3. Briefly explain the various ways in which acids can be identified scientifically.
4. Mention four everyday substances in which acids can be found.
5. Write three chemical formula of some of the common acids used in the chemistry laboratories

   The teacher will ask the group leaders to collect the answers to the questions, which he will later mark and score it for each student and return them during the next lesson.

LESSON TWO

Topic: The Concepts of Base.

Week: Two (2)

Level: SS II

Length of class period: 90 min.

Main activity: Defining a base, physical and chemical properties of bases, identification of bases, bases in everyday substances and types of bases

Model of Teaching: Cooperative learning (jigsaw) model

Learning Objective:

Cognitive:

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

- Define base.
- State physical and chemical properties of base.
- Mention ways in which base can be identify scientifically.
- Recognize base in everyday substances.
- classify base.

Affective:

The students will learn how to work cooperatively in group by working together and helping each other.

Psychomotor:

Students moves from Jigsaw main groups to Expert groups and back to Jigsaw groups

and interact/communicate with one another.

Materials:

- Worksheet for all students: A4 papers and writing materials

- Copies of study notes to all expert group students on:

1. Definitions of base
2. Physical properties of base
3. Chemical properties of base.
4. Ways in which base can be identify scientifically
5. Bases in everyday substances
6. Classification of base

Activity outline for expert groups (EGR)

EGR 1. Members of this expert group are to discuss on the following specific areas:

1. Bronsted Lowry definition.

2. Arrhenius definition.

3. Examples of common bases with their chemical formula.

EGR 2. Members of this group are to discuss on the following specific areas:

1. Physical properties of bases

EGR 3. Members of this group are to discuss on the following specific areas:

1. Chemical properties of bases

EGR 4. Members of this group are to discuss on the following specific areas:

1. Identification of acid using scientific approaches

EGR 5. Members of this group are to discuss on the following specific areas:

1. Base in everyday substances
2. Classification of base

Roles/Responsibilities:

Leader:Collect group folders containing materials.

Distribute materials to group members

Return materials to folders then to teacher

Reader: Reads the group task to the group

Timer: Keeps truck of the time

Makes sure everyone contributes to answer the questions within the stipulated time

Organizer: - Encourages group members

- Decides on the order for the members to read the task

Presentation:

Teacher Activity

Step 1. The teacher will inform the students that they are going to learn the concept of acid using a cooperative learning strategy where all of them will work cooperatively together, and that the success of the group depends on the success of the individual member of the group. Therefore they are expected to work as a team, whereby every member of the group is working towards the success of his/her group.

Step 2. The teacher will then group the students into the main cooperative learning group comprising of five to six students per group. Making sure that the groups are heterogeneous in nature.

Step 3. The teacher will then explain what the students are expected to be doing from the beginning to the end of the lesson including the social skills they are expected to learn and apply in their interaction with one another during their group work. These skills may include using group names, expert names, timing, asking questions and the rest.

Students' Activity:

Group Tasks

1. Collect and distribute the materials (A4 paper/writing materials and study notes).

2. Take turn reading and highlighting the important information.

3. As a group, decide what information should be highlighted.

4. As a group, answer the questions.

5. Each member must fill in their activity sheet.

6. Return the materials and group member activity sheet.

Specific procedure:

To begin the lesson, the teacher will give each group name written on a card. Each individual member of the group will then be given specific task to work/study. His expert name attached to the study note of the task given to him/her will be provided to him/her. Each expert will be asked to study his/her task for some time. No student in the same group will be allowed to see the task given to his fellow group member. In case of a task which is too demanding, a helper can be attached to the student who will represent the main group in the expert group. Students studying the same task from each group will then be asked to form expert groups where they will study collectively the task and record useful information on the worksheet earlier provided for the purpose of feed back to his/her main (cooperative) group.

Members of the expert groups will after some time be asked to break and go back to their main cooperative groups where each expert will explain his/her task to the remaining members of his group. Other members of the group will be encouraged to ask questions and clarification from the expert. As the group discussion is on, members of the group assigned to perform certain role like the time keeper, questioner, reader, reminder, and so forth will be doing their job while the teacher goes round to support them.

Evaluation:

Each group will answer the following questions at the end of the group discussion to evaluate learning outcome:

1. Define base.

2. State the physical and chemical properties of bases.

3. Briefly explain the various ways in which bases can be identified scientifically.

4. Mention four everyday substances in which base can be found.

5. Write three chemical formula of some of the common bases used in the chemistry laboratories

The teacher will ask the group leaders to collect the answers to the questions, which he will later mark and score it for each student and return them during the next lesson.

LESSON THREE

Topic: Introduction to materials and apparatus needed for volumetric analysis.

Week: Three (3)

Level: SS II

Length of class period: 90 min.

Main activity: Defining apparatus, defining materials, differentiate between apparatus and materials, List apparatus needed for volumetric analysis, care in handling of volumetric Glassware andcalibration of glassware

Model of Teaching: Cooperative learning (jigsaw) model

Learning Objective:

Cognitive:

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

- Define apparatus.
- Define materials.
- Differentiate between apparatus and materials.
- List apparatus needed for volumetric analysis.
- Explain ways for handling of volumetric Glassware.
- Explain calibration of glassware used in volumetric Glassware

Affective:

The students will learn how to work cooperatively in group by working together and helping each other.

Psychomotor:

Students moves from Jigsaw main groups to Expert groups and back to Jigsaw groups and interact/communicate with one another.

Materials:

- Worksheet for all students: A4 papers and writing materials
- Copies of study notes to all expert group students on:

1. Definitions of apparatus.

2. Definitions of materials.

3. Differences between apparatus and materials.

4. List of apparatus needed for volumetric analysis.

5. Explanations on ways for handling and care of volumetric Glassware.

6. Explanations on calibration on glassware used in volumetric analysis.

Activity outline for expert groups (EGR)

EGR 1. Members of this expert group are to discuss on the following specific area:

Apparatus in volumetric analysis.

EGR 2. Members of this group are to discuss on the following specific area:

Materials in volumetric analysis

EGR 3. Members of this group are to discuss on the following specific areas:

Differences between apparatus and materials.

EGR 4. Members of this group are to discuss on the following specific areas:

Apparatus needed for volumetric analysis.

EGR 5. Members of this group are to discuss on the following specific areas:

- Ways for handling and care of volumetric Glassware.

-Calibration on glassware used in volumetric analysis.

Roles/Responsibilities:

Leader:Collect group folders containing materials.

Distribute materials to group members

Return materials to folders then to teacher

Reader: Reads the group task to the group

Timer: Keeps truck of the time

Makes sure everyone contributes to answer the questions within the stipulated time

Organizer: Encourages group members

Decides on the order for the members to read the task

Presentation:

Teacher Activity

Step 1. The teacher will inform the students that they are going to learn the concept of acid using a cooperative learning strategy where all of them will work cooperatively together, and that the success of the group depends on the success of the individual member of the group. Therefore they are expected to work as a team, whereby every member of the group is working towards the success of his/her group.

Step 2. The teacher will then group the students into the main cooperative learning group comprising of five to six students per group. Making sure that the groups are heterogeneous in nature.

Step 3. The teacher will then explain what the students are expected to be doing from the beginning to the end of the lesson including the social skills they are expected to learn and apply in their interaction with one another during their group work. These skills may include using group names, experts' names, timing, asking questions and the rest.

Students' Activity:

Group Tasks

1. Collect and distribute the materials (A4 paper/writing materials and study notes).

2. Take turn reading and highlighting the important information.

3. As a group, decide what information should be highlighted.

4. As a group, answer the questions.

5. Each member must fill in their activity sheet.

6. Return the materials and group member activity sheet.

Specific procedure:

To begin the lesson, the teacher will give each group name written on a card. Each individual member of the group will then be given specific task to work/study. His expert name attached to the study note of the task given to him/her will be provided to him/her. Each expert will be asked to study his/her task for some time. No student in the same group will be allowed to see the task given to his fellow group member. In case of a task which is too demanding, a helper can be attached to the student who will represent the main group in the expert group. Students studying the same task from each group will then be asked to form expert groups where they will study collectively the task and record useful information on the worksheet earlier provided for the purpose of feed the time keeper, questioner, reader, reminder, and so forth will be doing their job while the teacher goes round to support them.

Evaluation:

In each group, the organizer should encourage members to write or mention at least two important points which they understand better. The teacher goes round to watch what is going on in the main (jigsaw) groups.

LESSON FOUR

Topic: Volumetric analysis.

Week: Four (4)

Level: SS II

Length of class period: 90 min.

Main activity: Defining volumetric analysis, uses of burette, pipette, volumetric flask, wash bottle, retort stand and others; procedure, and basic principles of volumetric analysis.

Model of Teaching: Cooperative learning (jigsaw) model

Learning Objective:

Cognitive:

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

- Define volumetric analysis.

- State uses of burette, pipette, volumetric flask, wash bottle, retort stand and other relevant apparatus used in volumetric analysis.

- Explain procedures in conducting volumetric analysis.

- Explain the basic principles in volumetric analysis.

Affective:

The students will learn how to work cooperatively in group by working together and helping each other.

Psychomotor:

Students moves from Jigsaw main groups to Expert groups and back to Jigsaw groups and interact/communicate with one another.

Materials:

- Worksheet for all students: A4 papers and writing materials
- Copies of study notes to all expert group students on:

1. Definitions of volumetric analysis
2. Uses of burette, pipette, volumetric flask, wash bottle, retort stand, conical flask, beaker, funnel etc.
3. Procedures in conducting volumetric analysis.
4. Basic principles of volumetric analysis

Activity outline for expert groups (EGR)

EGR 1. Members of this expert group are to discuss on the following specific areas:

Volumetric analysis.

EGR 2. Members of this group are to discuss on the following specific areas:

Uses of burette and pipette

EGR 3. Members of this group are to discuss on the following specific areas:

Uses of volumetric flask, wash bottle, retort stand, conical flask, beaker and funnel

EGR 4. Members of this group are to discuss on the following specific areas:

Procedures in conducting volumetric analysis.

EGR 5. Members of this group are to discuss on the following specific areas:

Basic principles of volumetric analysis.

Roles/Responsibilities:

Leader:Collect group folders containing materials.

Distribute materials to group members

Return materials to folders then to teacher

Reader: Reads the group task to the group

Timer: Keeps truck of the time

Makes sure everyone contributes to answer the questions within the stipulated time

Organizer: Encourages group members

Decides on the order for the members to read the task

Presentation:

Teacher Activity

Step 1. The teacher will inform the students that they are going to learn the concept of acid using a cooperative learning strategy where all of them will work cooperatively together, and that the success of the group depends on the success of the individual member of the group. Therefore they are expected to work as a team, whereby every member of the group is working towards the success of his/her group.

Step 2. The teacher will then group the students into the main cooperative learning group comprising of five to six students per group. Making sure that the groups are heterogeneous in nature.

Step 3. The teacher will then explain what the students are expected to be doing from the beginning to the end of the lesson including the social skills they are expected to learn and apply in their interaction with one another during their group work. These skills may include using group names, expert names, timing, asking questions and the rest.

Students' Activity:

Group Tasks

1. Collect and distribute the materials (A4 paper/writing materials and study notes).
2. Take turn reading and highlighting the important information.
3. As a group, decide what information should be highlighted.
4. As a group, answer the questions.

5. Each member must fill in their activity sheet.

6. Return the materials and group member activity sheet.

Specific procedure:

To begin the lesson, the teacher will give each group name written on a card. Each individual member of the group will then be given specific task to work/study. His expert name attached to the study note of the task given to him/her will be provided to him/her. Each expert will be asked to study his/her task for some time. No student in the same group will be allowed to see the task given to his fellow group member. In case of a task which is too demanding, a helper can be attached to the student who will represent the main group in the expert group. Students studying the same task from each group will then be asked to form expert groups where they will study collectively the task and record useful information on the worksheet earlier provided for the purpose of feed the time keeper, questioner, reader, reminder, and so forth will be doing their job while the teacher goes round to support them.

Evaluation:

Each group will answer the following questions at the end of the group discussion to evaluate learning outcome:

1. Define volumetric analysis.

2. State uses of burette and pipette.

3. Briefly explain the procedures in conducting volumetric analysis.

The teacher will ask the group leaders to collect the answers to the questions, which he will later mark and score it for each student and return them during the next lesson.

LESSON FIVE

Topic: Standard solution.

Week: Five (5)

Level: SS II

Length of class period: 90 min.

Main activity: Defining standard solution, defining concentration in mol dm^{-3} of solution, explaining relationship between concentrations and volumes of reacting substances, express mathematically the relationship between the concentration in mol dm^{-3} and volume of a solution.

Model of Teaching: Cooperative learning (jigsaw) model

Learning Objective:

Cognitive:

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

- Define standard solution.
- Define concentration in mol dm^{-3} of solution.
- Explain the relationship between concentrations and volumes of reacting substances.
- Express mathematically, the relationship between the concentration in mol dm^{-3} and volume of a solution.

Affective:

The students will learn how to work cooperatively in group by working together and helping each other.

Psychomotor:

Students moves from Jigsaw main groups to Expert groups and back to Jigsaw groups and interact/communicate with one another.

Materials:

- Worksheet for all students: A4 papers and writing materials
- Copies of study notes to all expert group students on:

1. Definitions of standard solution.
2. Definitions of concentration in mol dm^{-3} of solution.
3. Molar concentration
4. Explanation the relationship between concentrations and volumes of reacting substances.
5. Mathematical expression on the relationship between the concentration in mol dm^{-3} and volume of a solution.

Activity outline for expert groups (EGR)

EGR 1. Members of this expert group are to discuss on the following specific areas: Definitions of standard solution.

EGR 2. Members of this group are to discuss on the following specific areas: Definitions of concentration in mol dm-3 of solution.

EGR 3. Members of this group are to discuss on the following specific areas: Explanation onmolar concentration.

EGR 4. Members of this group are to discuss on the following specific areas:

Explanation the relationship between concentrations and volumes of reacting substances.

EGR 5. Members of this group are to discuss on the following specific areas:

Mathematical expression on the relationship between the concentration in mol dm^{-3} and volume of a solution.

Roles/Responsibilities:

Leader:Collect group folders containing materials. Distribute materials to group members. Return materials to folders then to teacher

Reader: Reads the group task to the group

Timer: Keeps truck of the time. Makes sure everyone contributes to answer the questions within the stipulated time

Organizer: Encourages group members. Decides on the order for the members to read the task

Presentation:

Teacher Activity

Step 1. The teacher will inform the students that they are going to learn the concept of acid using a cooperative learning strategy where all of them will work cooperatively together, and that the success of the group depends on the success of the individual member of the group. Therefore they are expected to work as a team, whereby every member of the group is working towards the success of his/her group.

Step 2. The teacher will then group the students into the main cooperative learning group comprising of five to six students per group. Making sure that the groups are heterogeneous in nature.

Step 3. The teacher will then explain what the students are expected to be doing from the beginning to the end of the lesson including the social skills they are expected to learn and apply in their interaction with one another during their group work. These skills may include using group names, expert names, timing, asking questions and the rest.

Students' Activity:

Group Tasks

1. Collect and distribute the materials

2. Take turn reading and highlighting the important information.

3. As a group, decide what information should be highlighted.

4. As a group, answer the questions.

5. Each member must fill in their activity sheet.

6. Return the materials and group member activity sheet.

Specific procedure:

To begin the lesson, the teacher will give each group name written on a card. Each individual member of the group will then be given specific task to work/study. His expert name attached to the study note of the task given to him/her will be provided to him/her. Each expert will be asked to study his/her task for some time. No student in the same group will be allowed to see the task given to his fellow group member. In case of a task which is too demanding, a helper can be attached to the student who will represent the main group in the expert group. Students studying the same task from each group will then be asked to form expert groups where they will study collectively the task and record useful information on the worksheet earlier provided for the purpose of feed the time keeper, questioner, reader, reminder, and so forth will be doing their job while the teacher goes round to support them.

Evaluation:

Each group will answer the following questions at the end of the group discussion to evaluate learning outcome:

- Define standard solution.

- Define concentration in mol dm^{-3} of solution.

- Explain the relationship between concentrations and volumes of reacting substances.

- Express mathematically, the relationship between the concentration in mol dm^{-3} and volume of a solution.

The teacher will ask the group leaders to collect the answers to the questions, which he will later mark and score it for each student and return them during the next lesson.

LESSON SIX

Topic: acid base titration.

Week: Six (6)

Level: SS II

Length of class period: 90 min.

Main activity: Defining neutralization reaction and identifying meniscus level, taking reading from burette and pipette, use pipette and burette correctly, use of indicators to identify change of colours in titration and recording burette readings.

Model of Teaching: Cooperative learning (jigsaw) model

Learning Objective:

Cognitive:

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

- Define neutralization reaction, titration and explain how to identify meniscus level during acid base titration.
- Explain how to take reading from burette and pipette during acid base titration
- Explain how to use pipette and burette correctly during acid base titration.
- Identify use of indicators to determine change of colours in acid base titration.
- Record burette readings correctly.

Affective:

The students will learn how to work cooperatively in group by working together and helping each other.

Psychomotor:

Students moves from Jigsaw main groups to Expert groups and back to Jigsaw groups and interact/communicate with one another.

Materials:

- Worksheet for all students: A4 papers and writing materials
- Copies of study notes to all expert group students on:

1. Definitions, neutralization reaction, and explanation on meniscus level.
2. Calibrated marks and numbers used in taking reading from burette and pipette.
3. Explanation on how to use pipette and burette correctly during acid base titration.
4. Colours of indicators used to determine change of in concentration during acid base titration.
5. Introduction of table used to record burette readings correctly and how to record it.

Activity outline for expert groups (EGR)

EGR 1. Members of this expert group are to discuss on the following specific area:

Definitions of titration and neutralization reaction, and explanation on meniscus level.

EGR 2. Members of this group are to discuss on the following specific area:

Calibrated marks and numbers used in taking reading from burette and pipette.

EGR 3. Members of this group are to discuss on the following specific areas:

Explanation on how to use pipette and burette correctly during acid base titration.

EGR 4. Members of this group are to discuss on the following specific areas:

Colours of indicators used to determine change of in concentration during acid base titration.

EGR 5. Members of this group are to discuss on the following specific areas:

Introduction of table used to record burette readings correctly and how to use it.

Roles/Responsibilities:

Leader:Collect group folders containing materials.

Distribute materials to group members

Return materials to folders then to teacher

Reader: Reads the group task to the group

Timer: Keeps truck of the time

Makes sure everyone contributes to answer the questions within the stipulated time

Organizer: Encourages group members

Decides on the order for the members to read the task

Presentation:

Teacher Activity

Step 1. The teacher will inform the students that they are going to learn the concept of acid using a cooperative learning strategy where all of them will work cooperatively together, and that the success of the group depends on the success of the individual member of the group. Therefore they are expected to work as a team, whereby every member of the group is working towards the success of his/her group.

Step 2. The teacher will then group the students into the main cooperative learning group comprising of five to six students per group. Making sure that the groups are heterogeneous in nature.

Step 3. The teacher will then explain what the students are expected to be doing from the beginning to the end of the lesson including the social skills they are expected to learn and apply in their interaction with one another during their group work. These skills may include using group names, expert names, timing, asking questions and the rest.

Students' Activity:

Group Tasks

1. Collect and distribute the materials

2. Take turn reading and highlighting the important information.

3. As a group, decide what information should be highlighted.

4. As a group, answer the questions.

5. Each member must fill in their activity sheet.

6. Return the materials and group member activity sheet.

Specific procedure:

To begin the lesson, the teacher will give each group name written on a card. Each individual member of the group will then be given specific task to work/study. His expert name attached to the study note of the task given to him/her will be provided to him/her. Each expert will be asked to study his/her task for some time. No student in the same group will be allowed to see the task given to his fellow group member. In case of a task which is too demanding, a helper can be attached to the student who will represent the main group in the expert group. Students studying the same task from each group will then be asked to form expert groups where they will study collectively the task and record useful information on the worksheet earlier provided for the purpose of feed the time keeper, questioner, reader, reminder, and so forth will be doing their job while the teacher goes round to support them.

Evaluation:

In each group, the organizer should encourage members to write or mention at least two important points which they understand better. The teacher goes round to watch what is going on in the main (jigsaw) groups.

LESSON SEVEN

Topic: The pH scale.

Week: Seven (7)

Level: SS II

Length of class period: 90 min.

Main activity: Defining and measuring pH, application of pH, calculation of pH.

Model of Teaching: Cooperative learning (jigsaw) model

Learning Objective:

Cognitive:

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

- Define and measure pH.

- Explain the application of pH.

- Perform basic calculations on pH.

Affective:

The students will learn how to work cooperatively in group by working together and helping each other.

Psychomotor:

Students moves from Jigsaw main groups to Expert groups and back to Jigsaw groups and interact/communicate with one another.

Materials:

- Worksheet for all students: A4 papers and writing materials
- Copies of study notes to all expert group students on:

1. Definitions and measurement of pH.
2. Application of pH.
3. Calculations on pH.

Activity outline for expert groups (EGR)

EGR 1. Members of this expert group are to discuss on the following specific areas:

Define and measure pH, p[H] and pH indicators.

EGR 2. Members of this group are to discuss on the following specific areas:

Define and measure extremes of pH, pOH and non-aqueous solutions.

EGR 3. Members of this group are to discuss on the following specific areas:

Application of pH and classification of pH ranges.

EGR 4. Members of this group are to discuss on the following specific areas:

Applications of pH in nature; on rain and seawater.

EGR 5. Members of this group are to discuss on the following specific areas:

Calculations of pH on strong acids and bases, and weak acids and bases.

Roles/Responsibilities:

Leader:Collect group folders containing materials.

Distribute materials to group members

Return materials to folders then to teacher

Reader: Reads the group task to the group

Timer: Keeps truck of the time

Makes sure everyone contributes to answer the questions within the

stipulated time

Organizer: Encourages group members

Decides on the order for the members to read the task

Presentation:

Teacher Activity

Step 1. The teacher will inform the students that they are going to learn the concept of acid using a cooperative learning strategy where all of them will work cooperatively together, and that the success of the group depends on the success of the individual member of the group. Therefore they are expected to work as a team, whereby every member of the group is working towards the success of his/her group.

Step 2. The teacher will then group the students into the main cooperative learning group comprising of five to six students per group. Making sure that the groups are heterogeneous in nature.

Step 3. The teacher will then explain what the students are expected to be doing from the beginning to the end of the lesson including the social skills they are expected to learn and apply in their interaction with one another during their group work. These skills may include using group names, expert names, timing, asking questions and the rest.

Students' Activity:

Group Tasks

1. Collect and distribute the materials
2. Take turn reading and highlighting the important information.
3. As a group, decide what information should be highlighted.
4. As a group, answer the questions.
5. Each member must fill in their activity sheet.
6. Return the materials and group member activity sheet.

Specific procedure:

To begin the lesson, the teacher will give each group name written on a card. Each individual member of the group will then be given specific task to work/study. His expert name attached to the study note of the task given to him/her will be provided to him/her. Each expert will be asked to study his/her task for some time. No student in the same group will be allowed to see the task given to his fellow group member. In case of a task which is too demanding, a helper can be attached to the student who will represent the main group in the expert group. Students studying the same task from each group will then be asked to form expert groups where they will study collectively the task and record useful information on the worksheet earlier provided for the purpose of feed the time keeper, questioner, reader, reminder, and so forth will be doing their job while the teacher goes round to support them.

Evaluation:

Each group will answer the following questions at the end of the group discussion to evaluate learning outcome:

- Define and measure pH.
- Explain the application of pH.
- Perform basic calculations on pH.

The teacher will ask the group leaders to collect the answers to the questions, which he will later mark and score it for each student and return them during the next lesson.

LESSON EIGHT

Topic: Revision/summary on acid –base concepts and reactions.

Week: Eight (8)

Level: SS II

Length of class period: 90 min.

Main activity: Students within their jigsaw main groups review the summary of the experts group on the topics covered, that is; concept of acids, concept of base, introduction to materials and use of apparatus in volumetric analysis, , volumetric analysis, standard solutions, acid –base titration and the pH scale.

Model of Teaching: Cooperative learning (jigsaw) model

Learning Objective:

Cognitive:

By the end of the lesson, the students in the various jigsaw groups should be able to summarize the important points discussed and be able to perform basic calculations involved in the various topics.

Affective:

The students will learn how to work cooperatively in group by working together inpairs, individually or in groups by helping each other as the case may be.

Psychomotor:

Students moves from Jigsaw main groups to Expert groups and back to Jigsaw groups, and interact/communicate with one another.

Materials:

- Worksheet for all students: A4 papers and writing materials
- Copies of study notes to all expert group students on:

Presentation:

Teacher Activity

Step 1. The teacher will inform the students that they are going to learn the concept of acid and base using a cooperative learning strategy once again where all of them will work cooperatively together. Therefore they are expected to work as a team, whereby every member of the group is working towards the success of his/her group.

Step 2. The students will be informed that this time they are going to work in their jigsaw groups to rub minds together in reviewing and summarizing the important items discussed in the tasks given to them.

Step 3. The teacher will then explain what the students are expected to be doing from the beginning to the end of the lesson including the social skills they are expected to learn and apply in their interaction with one another during their group work. The teacher will then visit the various group to watch and support them while working on the review/summary.

Students' Activity:

Group Tasks

Those representative of the groups who visited the experts groups on the various tasks and all the groups should agree on what should actually be their summary on the individual tasks and this will form the basis of the grand summary of the work.

Evaluation:

In each group, the organizer should encourage members to participate in making the summary a good one which will cover all the topics discussed during the treatment.

APPENDIX D

LESSON PLAN FOR EXPERIMENTAL GROUP TWO (LABORATORY METHOD)

LESSON ONE

Topic: Concepts of acids.

Week: One (1)

Level: SS II

Length of class period: 90 min.

Main activity: Students will work in the laboratory with apparatus and materials. Students will see and touch apparatus/materials or use them in practical lessons where applicable.

Model of Teaching: Laboratory method model

Learning Objective:

Cognitive:

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

- Define acids.
- State physical and chemical properties of acids.
- Mention ways in which acids can be identify scientifically.
- Recognize acids in everyday substances.
- classify acids.

Affective:

The students will learn how to work with materials and apparatus in chemistry laboratory in groups or in pairs, with the support of the teacher. Identify acids with their properties by touching, tasting and seeing.

Psychomotor:

Students works with materials/apparatus in the laboratory to learn the concept of acids.

Materials:

Reagent bottles containing acids, lemon, litmus paper, wash bottle containing water and handouts containing theories on the concepts of acid.

Presentation:

Teacher Activity

Step 1. The teacher will inform the students that they are going to learn the concept of acid using laboratory method where all of them will work together in the laboratory. Therefore they are expected to handle materials and apparatus with care.

Step 2. The students will be sitting in heterogeneous groups which is formed by the teacher. The teacher will remind the students on the rules governing laboratory activities of not eating, playing or touching anything in the laboratory.

Step 3. The teacher will then explain what the students are expected to be doing from the beginning to the end of the lesson including the social skills they are expected to learn and apply in their interaction with the materials/apparatus and one another during the laboratory work. The teacher will then visit the various group to watch and support them while working.

Students' Activity:

Group Tasks

The students will work together to identify acids by seeing, smelling and tasting it with litmus paper. Students will taste lemon and other unripe fruits to identify its acidic properties. Individual members of the groups should record their observation which they will later compare with the contents of the handouts.

Teacher will at this juncture briefly explain the theories on the concepts of acid and issue the handouts to the individual students.

Evaluation:

Individuals students from the groups will be asked to define acid, mention the colour of litmus paper in acids and state some of the properties of acid.

LESSON TWO

Topic: Concepts of base.

Week: Two (2)

Level: SS II

Length of class period: 90 min.

Main activity: Students will work in the laboratory with apparatus and materials. Students will see and touch apparatus/materials or use them in practical lessons where applicable.

Model of Teaching: Laboratory method model

Learning Objective:

Cognitive:

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

- Define base.
- State physical and chemical properties of bases.
- Mention ways in which bases can be identify scientifically.
- Recognize acids in everyday substances.
- classify bases.

Affective:

The students will learn how to work with materials and apparatus in chemistry laboratory in groups or in pairs, with the support of the teacher. Identify acids with their properties by touching, tasting and seeing.

Psychomotor:

Students mingles with materials/apparatus in the laboratory to learn the concept of base.

Materials:

Reagent bottles containing bases, ashes of wood, litmus paper, wash bottle containing water and handouts containing theories on the concepts of base.

Presentation:

Teacher Activity

Step 1. The teacher will inform the students that they are going to learn the concept of base using laboratory method where all of them will work together in the laboratory. Therefore they are expected to handle materials and apparatus with care.

Step 2. The students will be sitting in heterogeneous groups which is formed by the teacher. The teacher will remind the students on the rules governing laboratory activities of not eating, playing or touching anything in the laboratory.

Step 3. The teacher will then explain what the students are expected to be doing from the beginning to the end of the lesson including the social skills they are expected to learn and apply in their interaction with the materials/apparatus and one another during the laboratory work. The teacher will then visit the various group to watch and support them while working.

Students' Activity:

Group Tasks

The students will work together to identify bases by seeing, touching, smelling and tasting it with litmus paper. Students will taste touch and taste ash to identify its bases properties. Individual members of the groups should record their observation which they will later compare with the contents of the handouts.

Teacher will at this juncture briefly explain the theories on the concepts of base and issue the handouts to the individual students.

Evaluation:

Individuals students from the groups will be asked to define base, mention the colour of litmus paper in base and state some of the properties of base

LESSON THREE

Topic: Introduction to materials and apparatus needed for volumetric analysis.

Week: Three (3)

Level: SS II

Length of class period: 90 min.

Main activity: Students will work in the laboratory with apparatus and materials. Students will see and touch apparatus/materials or use them in practical lessons where applicable.

Model of Teaching: Laboratory method model

Learning Objective:

Cognitive:

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

- Define apparatus.
- Define materials.
- Differentiate between apparatus and materials.
- List apparatus needed for volumetric analysis.
- Explain ways for handling of volumetric Glassware.
- Explain calibration of glassware used in volumetric Glassware

Affective:

The students will learn how to work with materials and apparatus in chemistry laboratory in groups or in pairs, with the support of the teacher. Identify bases with their properties by touching, tasting and seeing.

Psychomotor:

Students mingles with materials/apparatus in the laboratory to learn about the equipment needed for volumetric analysis.

Materials:

Reagent bottles containing acids, bases, conical flasks, beakers, wash bottle, retort stand, burettes, pipettes, funnels and handouts containing the names and pictures of apparatus and materials, ways of handling them and all the information related to the practical activities.

Presentation:

Teacher Activity

Step 1. The teacher will inform the students that they are going to do in learning about the materials and apparatus needed for volumetric analysis using laboratory method where all of them will work together in the laboratory. Therefore they are expected to handle materials and apparatus with care.

Step 2. The students will be sitting in heterogeneous groups which is formed by the teacher. All the apparatus and the materials needed for the activities will be made available to the groups by the teacher. The teacher will remind the students on the rules governing laboratory activities of not eating, playing or touching anything in the laboratory until they are asked to do so.

Step 3. The teacher will then explain what the students are expected to be doing from the beginning to the end of the lesson including the skills they are expected to learn and apply in their interaction with the materials/apparatus and one another during the laboratory work. The teacher will give clear instructions to students on identifying and handling the materials and apparatus, and then visit the various group to watch and support them while working.

Students' Activity:

Group Tasks

The students will work together to identify materials and apparatus needed for volumetric analysis by seeing and touching, Students will try and see the levels and the calibrations on the glass wares and what they actually represent. Individual members of the groups should record their observation which they will later compare with the contents of the handouts.

Teacher will at this juncture briefly explain the theories behind the materials and apparatus needed for volumetric analysis and issue the handouts to the individual students.

Evaluation:

Individuals students from the groups will be asked to identify some of these apparatus/materials needed for volumetric analysis and state ways in which thy can be handled properly during volumetric analysis.

LESSON FOUR

Topic: Volumetric analysis.

Week: Four (4)

Level: SS II

Length of class period: 90 min.

Main activity: Students will work in the laboratory with apparatus and materials. Students will see and touch apparatus/materials or use them in practical lessons where applicable.

Model of Teaching: Laboratory method model

Learning Objective:

Cognitive:

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

- State uses of burette, pipette, volumetric flask, wash bottle, retort stand and other relevant apparatus used in volumetric analysis.
- Demonstrate how to use pipette and burette
- Explain procedures in conducting volumetric analysis.
- Explain the basic principles in volumetric analysis.

Affective:

The students will learn how to work with materials and apparatus in chemistry laboratory in groups or in pairs, with the support of the teacher. Identify and demonstrate how to use pipette and burette.

Psychomotor:

Students works with materials/apparatus in the laboratory to learn volumetric analysis.

Materials:

Reagent bottles containing acids, bases, conical flasks, beakers, wash bottle, retort stand, burettes, pipettes, funnels and handouts containing the theoretical aspect of the laboratory activities.

Presentation:

Teacher Activity

Step 1. The teacher will inform the students that they are going to learn about Volumetric analysis using laboratory method where all of them will work together in the laboratory. Therefore they are expected to watch what the teacher does and handle materials and apparatus with care.

Step 2. The students will be sitting in heterogeneous groups which is formed by the teacher. All the apparatus and the materials needed for the activities will be made available to the groups by the teacher. The teacher will remind the students on the rules governing laboratory activities of not eating, playing or touching anything in the laboratory until they are asked to do so.

Step 3. The teacher will then explain what the students are expected to be doing from the beginning to the end of the lesson including the skills they are expected to learn and apply in their interaction with the materials/apparatus and one another during the laboratory work. The teacher will give clear instructions to students on identifying and handling the materials and apparatus. The teacher will demonstrate how to suck the base using ordinary water and then visit the various group to watch and support them while working.

Students' Activity:

Group Tasks

The students will work together in identifying and trying to use the apparatus. Students will try and see the levels and the calibrations on the glass wares and what they actually represent. Individual members of the groups should try to suck the water using pipette in order to establish some level of perfection before the actual sucking of the base. Students should try to read the calibrated meniscus level.

Teacher will at this juncture briefly explain what students are expected to do when working with the real reagents.

Evaluation:

Individuals students from the groups will be asked to identify pipette and burette and be able to use them with some level of accuracy.

LESSON FIVE

Topic: Standard solution.

Week: Five (5)

Level: SS II

Length of class period: 90 min.

Main activity: Students will work in the laboratory with apparatus and materials. Students will see and touch apparatus/materials and use them in preparing a standard solution.

Model of Teaching: Laboratory method model

Learning Objective:

Cognitive:

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

- Define standard solution.

- Define concentration in mol dm^{-3} of solution.

- Prepare a standard solution of sodium carbonate

- Explain the relationship between concentrations and volumes of reacting substances.

- Express mathematically, the relationship between the concentration in mol dm^{-3} and volume of a solution.

Affective:

The students will learn how to work with materials and apparatus in chemistry laboratory in groups or in pairs, with the support of the teacher. Identify and demonstrate how to use pipette and burette.

Psychomotor:

Students works with materials/apparatus in the laboratory to learn about standard solution.

Materials:

Reagent bottle containing a sample of sodium carbonate, accurate balance, watch glass, spatula, glass rod volumetric flask, filter funnel, beakers, wash bottle and handouts containing the theoretical aspect on standard solution.

Presentation:

Teacher Activity

Step 1. The teacher will inform the students that they are going to learn about standard solution using laboratory method where all of them will work together in the laboratory in preparing standard solution. Therefore they are expected to watch what the teacher does and handle materials and apparatus with care.

Step 2. The students will be sitting in heterogeneous groups which is formed by the teacher. All the apparatus and the materials needed for the activities will be made available to the groups by the teacher. The teacher will remind the students on the rules governing laboratory activities of not eating, playing or touching anything in the laboratory until they are asked to do so.

Step 3. The teacher will then explain what the students are expected to be doing from the beginning to the end of the lesson including the skills they are expected to learn and apply in their interaction with the materials/apparatus and one another during the laboratory work. The teacher will give clear instructions to students on identifying and handling the materials and apparatus. The teacher will demonstrate how to weigh and prepare a standard solution and then visit the various group to watch and support them while working.

Students' Activity:

Group Tasks

The students will work together in preparing a standard solution. Students will try to weigh the sample of anhydrous sodium trioxocarbonate(IV). Individual members within their groups should try to participate in the activity for them to be familiar with the process. Students should try to work with some level of accuracy for a better result of the experiment. The groups should work together to calculate the results of their laboratory work.

Teacher will at this juncture emphasize on what students are expected to do when working with the reagents and weighing balance.

Evaluation:

Individuals students from the groups will be asked to look at the theories on the handouts and compare with their findings.

LESSON SIX

Topic: acid base titration.

Week: Six (6)

Level: SS II

Length of class period: 90 min.

Main activity: Students will work in the laboratory with apparatus and materials. Students will see and touch apparatus/materials and use them in conducting acid base titration.

Model of Teaching: Laboratory method model

Learning Objective:

Cognitive:

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

- Define neutralization reaction, titration and explain how to identify meniscus level during acid base titration.
- determine the concentration of a solution of hydrochloric acid
- Explain how to take reading from burette and pipette during acid base titration
- Demonstrate how to use pipette and burette correctly during acid base titration.
- Use indicators correctly to determine change of colours in acid base titration.
- Record burette readings correctly.

Affective:

The students will learn how to work with materials and apparatus in chemistry laboratory in groups or in pairs, with the support of the teacher. Identify and demonstrate how to use pipette and burette.

Psychomotor:

Students works with materials/apparatus in the laboratory to learn about acid base titration.

Materials:

Reagent bottle containing Hydrochloric acid solution and sodium hydroxide, burette, pipette, methyl orange indicator, volumetric flask, filter funnel, beakers, wash bottle and handouts containing the theoretical aspect on acid base titration.

Presentation:

Teacher Activity

Step 1. The teacher will inform the students that they are going to learn about acid base titration using laboratory method where all of them will work together in the laboratory Therefore they are expected to watch what the teacher does during the demonstration of the experiment and handle materials and apparatus with care.

Step 2. The students will be sitting in heterogeneous groups which is formed by the teacher. All the apparatus and the materials needed for the activities will be made available to the groups by the teacher. The teacher will remind the students on the rules governing laboratory activities of not eating, playing or touching anything in the laboratory until they are asked to do so.

Step 3. The teacher will then explain what the students are expected to be doing from the beginning to the end of the lesson including the skills they are expected to learn and apply in their interaction with the materials/apparatus and one another during the laboratory work. The teacher will give clear instructions to students on handling acid and base during the titration process. The teacher will demonstrate the process to the whole class and then visit the various group to watch and support them while working.

Students' Activity:

Group Tasks

The students will work together in conducting the experiment on acid base titration. Students will try to suck the base and fill the burette carefully and read the meniscus level very well on both the burette and pipette. Individual members within their groups should try to participate in the activity for them to be familiar with the process. After agreeing on burette reading during the titrations process, students should try to record the readings for further calculations. The groups should work together to calculate the results of their laboratory work.

Teacher will at this juncture emphasize on what students are expected to do when working with acids and bases in the laboratory.

Evaluation:

Individuals students from the groups will be asked to mention one thing that they have learnt from the experiment.

LESSON SEVEN

Topic: The pH scale.

Week: Seven (7)

Level: SS II

Length of class period: 90 min.

Main activity: Students will work in the laboratory with apparatus and materials. Students will see and touch apparatus/materials and use them to learn about the pH scale.

Model of Teaching: Laboratory method model

Learning Objective:

Cognitive:

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

- Define and measure pH.
- Explain the application of pH.
- Use pH metre to identify different pH ranges
- Perform basic calculations on pH.

Affective:

The students will learn how to work with materials and apparatus in chemistry laboratory in groups or in pairs, with the support of the teacher. Measure pH of soil and use pH metre to identify different pH ranges.

Psychomotor:

Students works with materials/apparatus in the laboratory to learn the pH scale.

Materials:

Test tubes, soil sample, beaker, spoon, glass rod, funnel and filter paper, barium tetraoxosulphate (VI) powder, universal indicator, colour charts, pH metre and handouts containing the theoretical aspect on pH.

Presentation:

Teacher Activity

Step 1. The teacher will inform the students that they are going to learn about pH using laboratory method where all of them will work together in the laboratory. Therefore they are expected to watch what the teacher does during the demonstration of the experiment and handle materials and apparatus with care.

Step 2. The students will be sitting in heterogeneous groups which is formed by the teacher. All the apparatus and the materials needed for the activities will be made available to the groups by the teacher. The teacher will remind the students on the rules governing laboratory activities of not eating, playing or touching anything in the laboratory until they are asked to do so.

Step 3. The teacher will then explain what the students are expected to be doing from the beginning to the end of the lesson including the skills they are expected to learn and apply in their interaction with the materials/apparatus and one another during the laboratory work. The teacher will give clear instructions to students on using pH metre and handling apparatus and reagents used in measuring the pH of soil. The teacher will demonstrate the process to the whole class and then visit the various group to watch and support them while working.

Students' Activity:

Group Tasks

The students will work together by using pH metre to determine the pH ranges of acid, base and neutral in between the two. Students will try to measure the pH of soil using barium tetraoxosulphate (VI) powder and universal indicator. Individual members within their groups should try to participate in the activity for them to be familiar with the process. The groups should work together to calculate the results of their laboratory work

Evaluation:

Individuals students from the groups will be asked to mention one thing that they have learnt from the experiment. Teacher will provide the write answers for groups to compare with their findings.

LESSON EIGHT

Topic: Revision/summary on acid –base concepts and reactions.

Week: Eight (8)

Level: SS II

Length of class period: 90 min.

Main activity: Students will work in the laboratory setting to review and summarize all the theories related to the topics covered, that is; concept of acids, concept of base, introduction to materials and use of apparatus in volumetric analysis, , volumetric analysis, standard solutions, acid –base titration and the pH scale.

Model of Teaching: Laboratory method model

Learning Objective:

Cognitive:

By the end of the lesson, the students within the laboratory settings, should be able to summarize the important points discussed and be able to perform basic calculations involved in the various topics.

Affective:

The students will learn how to work in group, in pairs or within the laboratory settings by seeing, touching or using materials and apparatus as the case may be.

Psychomotor:

Students communicates/ interacts with one another and the teacher in revising the reactions and discussing about the concepts learnt.

Materials:

- Worksheet for all students: A4 papers and writing materials
- Copies of study notes to all expert group students on.
- Laboratory materials/apparatus

Presentation:

Teacher Activity

Step 1. The teacher will inform the students that they are going to learn the concept of acid and base using a laboratory method once again where all of them will work together. Therefore teacher will create an avenue where students will go through their handouts, ask questions to members they worked with and even the teacher.

Step 2. The students will be informed that this time they are going to work together in the laboratory in order to rub minds in reviewing and summarizing the important theories behind the laboratory work.

Step 3. The teacher will then explain what the students are expected to be doing from the beginning to the end of the lesson including the cognitive/skills they are expected to learn and apply in their interaction with one another during their group work. The teacher will then visit the various group to watch and support them while working on the review/summary.

Students' Activity:

Group Tasks

The students will go through their handouts and discussed in their laboratory groups, ask questions among themselves and agree on what should actually be their summary on the important points from their work and the handouts, and this will form the basis of the grand summary of the work.

Evaluation:

In each group, the organizer should encourage members to participate in making the summary a good one which will cover all the topics discussed during the treatment.

APPENDIX E

LESSON PLAN FOR CONTROL GROUP (CONVENTIONAL METHOD)

LESSON ONE

WEEK: ONE (1)

SUBJECT: Chemistry

CLASS: SSII

TOPIC: Concepts of acids

METHOD OF TEACHING: Conventional Method

TIME: 45 Minutes

BEHAVIUORAL OBJECTIVES: By the end of the lesson, students should able to:

- Define acids.
- State physical and chemical properties of acids.
- Mention ways in which acids can be identify scientifically.
- Recognize acids in everyday substances.
- classify acids.

PREVIOUS KNOWLEDGE: Students have learnt about chemical combinations, periodic table and chemical reactions.

INTRODUCTION: The lesson introduced by asking students questions based on previous knowledge example;

1. Who can define chemical combination?
2. What is periodic table of element?
3. What is chemical reactions?

PRESENTATION: The lesson would be presented in steps as follows:

STEP 1: The teacher will define acids

STEP 2: The teacher states physical and chemical properties of acids.

STEP 3: The teacher Mention ways in which acids can be identify scientifically.

STEP 4: The teacher classify acids with examples.

SUMMARY: The lesson would be summarized by explaining the whole concept of acids that is Definition, properties, ways for identifying acids and the classification of acids.

EVALUATION: The lesson will be evaluated by asking questions on what has been taught, example;

- Define acid
- State two physical properties of acid
- What is a mineral acid?

LESSON TWO

WEEK: TWO (2)

SUBJECT: Chemistry

CLASS: SSII

TOPIC: Concepts of Base

METHOD OF TEACHING: Conventional Method

TIME: 45 Minutes

BEHAVIUORAL OBJECTIVES: By the end of the lesson, students should able to:

- Define base.
- State physical and chemical properties of bases.
- Mention ways in which bases can be identify scientifically.
- Recognize acids in everyday substances.
- classify bases.

PREVIOUS KNOWLEDGE: Students have learnt about acids.

INTRODUCTION: The lesson introduced by asking students questions based on previous knowledge example;

1. What is acid?
2. Who can state two chemical properties of acid?
3. What is the colour of litmus paper in acid?

PRESENTATION: The lesson would be presented in steps as follows:

STEP 1: The teacher will define base

STEP 2: The teacher states physical and chemical properties of bases.

STEP 3: The teacher Mention ways in which bases can be identify scientifically.

STEP 4: The teacher classify bases with examples.

SUMMARY: The lesson would be summarized by explaining the whole concept of base that is Definition, properties, ways for identifying base and the classification of base.

EVALUATION: The lesson will be evaluated by asking questions on what has been taught, example;

- Define base
- State two physical properties of base
- Who can mention two classes of base?

LESSON THREE

WEEK: Three (2)

SUBJECT: Chemistry

CLASS: SSII

TOPIC: Introduction to materials and apparatus needed for volumetric analysis.

METHOD OF TEACHING: Conventional Method

TIME: 45 Minutes

BEHAVIUORAL OBJECTIVES: By the end of the lesson, students should able to:

- Define apparatus.
- Define materials.
- Differentiate between apparatus and materials.
- List apparatus needed for volumetric analysis.
- Explain ways for handling of volumetric Glassware.
- Explain calibration of glassware used in volumetric Glassware

PREVIOUS KNOWLEDGE: Students have learnt about acids and bases

INTRODUCTION: The lesson introduced by asking students questions based on previous knowledge example;

1. Who can define base?
2. Who can state two physical properties of base?
3. Mention two types of base?

PRESENTATION: The lesson would be presented in steps as follows:

STEP 1: The teacher will define Apparatus and materials

STEP 2: The teacher will differentiate between apparatus and materials.

STEP 3: The teacher will list apparatus needed for volumetric analysis and explain ways for handling of volumetric Glassware

STEP 4: Teacher explains calibration on glassware used in volumetric analysis.

SUMMARY: The lesson would be summarized by explaining the whole concept of acids that is definition, differences between apparatus and materials, names of apparatus used in volumetric analysis and explanations on calibration on glassware.

EVALUATION: The lesson will be evaluated by asking questions on what has been taught, example;

- Define apparatus
- Differentiate between apparatus and materials
- Who can mention two way to follow in handling glassware?

LESSON FOUR

WEEK: Four (4)

SUBJECT: Chemistry

CLASS: SSII

TOPIC: Volumetric analysis.

METHOD OF TEACHING: Conventional Method

TIME: 45 Minutes

BEHAVIUORAL OBJECTIVES: By the end of the lesson, students should able to:

- State uses of burette, pipette, volumetric flask, wash bottle, retort stand and other relevant apparatus used in volumetric analysis.

- Explain procedures in conducting volumetric analysis.

- Explain the basic principles in volumetric analysis.

PREVIOUS KNOWLEDGE: Students have learnt about acids and bases

INTRODUCTION: The lesson introduced by asking students questions based on previous knowledge example;

1. Define apparatus
2. Differentiate between apparatus and materials
3. Who can mention two way to follow in handling glassware?

PRESENTATION: The lesson would be presented in steps as follows:

STEP 1: The teacher state the uses of burette, pipette, volumetric flask, wash bottle, retort stand and other relevant apparatus used in volumetric analysis.

STEP 2: The teacher explain procedures in conducting volumetric analysis.

STEP 3: Teacher explains the basic principles in volumetric analysis

SUMMARY: The lesson would be summarized by explaining the whole concept of volumetric analysis, the procedures and the principle involved in volumetric analysis.

EVALUATION: The lesson will be evaluated by asking questions on what has been taught, example;

1. Who can state the use of burette and pipette in volumetric analysis?
2. Who can briefly explain procedures in conducting volumetric analysis?

LESSON FIVE

WEEK: Five (5)

SUBJECT: Chemistry

CLASS: SSII

TOPIC: Standard solution.

METHOD OF TEACHING: Conventional Method

TIME: 45 Minutes

BEHAVIUORAL OBJECTIVES: By the end of the lesson, students should able to:

- Define standard solution.

- Define concentration in mol dm^{-3} of solution.

- Explain the relationship between concentrations and volumes of reacting substances.

- Express mathematically, the relationship between the concentration in mol dm^{-3} and volume of a solution.

PREVIOUS KNOWLEDGE: Students have learnt about volumetric analysis

INTRODUCTION: The lesson introduced by asking students questions based on previous knowledge example;

1. Define volumetric analysis.
2. What is the use of burette and pipette in volumetric analysis?

PRESENTATION: The lesson would be presented in steps as follows:

STEP 1: The teacher defines standard solution.

STEP 2: The teacher defines concentration in mol dm^{-3} of solution.

STEP 3: Teacher explains the relationship between concentrations and volumes of reacting substances.

STEP 4: The teacher mathematically, expressed the relationship between the concentration in mol dm^{-3} and volume of a solution.

SUMMARY: The lesson would be summarized by explaining the whole concept of standard solution, relating concentrations and volumes of reacting substances and mathematically, expressing the relationship between the concentration in mol dm^{-3} and volume of a solution.

EVALUATION: The lesson will be evaluated by asking questions on what has been taught, example;

1. Who can define standard solution?
2. Who can explains the relationship between concentrations and volumes of reacting substances?

LESSON SIX

WEEK: SIX (6)

SUBJECT: Chemistry

CLASS: SSII

TOPIC: Acid base titration

METHOD OF TEACHING: Conventional Method

TIME: 45 Minutes

BEHAVIUORAL OBJECTIVES: By the end of the lesson, students should able to:

- Define titration, neutralization reaction, and explain how to identify meniscus level during acid base titration.
- Determine the concentration of a solution of hydrochloric acid
- Explain how to take reading from burette and pipette during acid base titration
- Explain how to use pipette and burette correctly during acid base titration.
- Explain how to use indicators correctly to determine change of colours in acid base titration.
- Record burette readings correctly.

PREVIOUS KNOWLEDGE: Students have learnt about volumetric analysis and standard solution

INTRODUCTION: The lesson introduced by asking students questions based on previous knowledge example;

1. Define standard solution.
2. Define concentration in mol dm^{-3} of solution.
3. Explain the relationship between concentrations and volumes of reacting substances.

PRESENTATION: The lesson would be presented in steps as follows:

STEP 1: The teacher defines define titration, neutralization reaction, and explain how to identify meniscus.

STEP 2: The teacher using chemical formula and mathematical expressions, determine the concentration of a solution of hydrochloric acid

STEP 3: Teacher explains how to use pipette and burette correctly during acid base titration.

STEP 4: The teacher explain how to use indicators correctly to determine change of colours in acid base titration.

SUMMARY: The lesson would be summarized by explaining the whole concept of acid base titration, how to determine the concentration of a solution of hydrochloric acid during titration, and how to use pipette and burette correctly and the drop of methyl orange indicator needed during the titration process.

EVALUATION: The lesson will be evaluated by asking questions on what has been taught, example;

- Define titration and neutralization reaction
- Who can explain how to use pipette correctly when sucking base during acid base reaction?
- What is the minimum or maximum drop of methyl orange indicator needed to apply into the base during acid base titration?

LESSON SEVEN

WEEK: SEVEN (7)

SUBJECT: Chemistry

CLASS: SSII

TOPIC: The pH Scale

METHOD OF TEACHING: Conventional Method

TIME: 45 Minutes

BEHAVIUORAL OBJECTIVES: By the end of the lesson, students should able to:

- Define and measure pH.

- Explain the application of pH.

- Use pH metre to identify different pH ranges

- Perform basic calculations on pH.

PREVIOUS KNOWLEDGE: Students have learnt about acid base titration.

INTRODUCTION: The lesson introduced by asking students questions based on previous knowledge example;

1. Define titration and neutralization reaction,
2. Explain how to identify meniscus level during acid base titration.
3. Explain how to use pipette correctly during acid base titration.

PRESENTATION: The lesson would be presented in steps as follows:

STEP 1: The teacher explained pH and how to measure pH.

STEP 2: The teacher Explain how pH can be applied in scientific process.

STEP 3: Teacher explains how to use pH metre to identify different pH ranges.

STEP 4: The teacher Perform basic calculations on pH.

SUMMARY: The lesson would be summarized by explaining the whole concept pH, which include the measurement, application, use of pH metre and calculations to do with the pH.

EVALUATION: The lesson will be evaluated by asking questions on what has been taught, example;

- What is pH.?
- Who can explain the trend in pH from the pH of water (7) moving towards right?

LESSON EIGHT

WEEK: EIGHT (8)

SUBJECT: Chemistry

CLASS: SSII

TOPIC: Revision/summary on acid –base concepts and reactions.

METHOD OF TEACHING: Conventional Method

TIME: 45 Minutes

BEHAVIUORAL OBJECTIVES: By the end of the lesson, the students should be able to summarize the important points discussed and be able to perform basic calculations involved in the various topics covered during the lessons

PREVIOUS KNOWLEDGE: Students have learnt about have learnt about the topics.

INTRODUCTION: The lesson introduced by asking students questions based on previous knowledge example;

Who can mention some of the topics so far covered in the past few weeks?

PRESENTATION: The lesson would be presented in steps as follows:

Step 1. The teacher will ask the students take out their notes for the purpose of the review.

Step 2. The teacher will try to read the important point which summarizes the seventh week lessons to the whole class.

Step 3: Therefore teacher will create an avenue where students will go through their handouts and ask questions on the lessons treated. The teacher at this juncture, will provide appropriate answers to students' questions.

SUMMARY: Using the handouts which is made available to all the students, teacher will mention all the topics and sub topics so far treated.

EVALUATION: The teacher will ask individual students to mention one new thing which they learnt during the teaching/learning process.

APPENDIX F
RELIABILITY OF ABPT INSTRUMENT FOR THE PILOT TEST
Reliability Result: Case Processing Summary

		N	%
Cases	Valid	40	100.0
	Excluded[a]	0	.0
	Total	40	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Part 1	Value	40[a]
		N of Items	40[b]
	Part 2	Value	.[a]
		N of Items	1[c]
	Total N of Items		2
Correlation Between Forms			.621
Spearman-Brown Coefficient	Equal Length		.770
	Unequal Length		.724

a. The item is: Scores
b. The item is: Group

Summary Item Statistics

		Mean	Minimum	Variance	N of Items	Maximum	Range	Group Reliability
Item Means	Part 1	7.432	6.512	.000	50[a]			
	Part 2	2.208	1.128	.000	40[b]			
	Both Parts	7.011	1.190	50.001	2	7.982	7.114	6.140
Inter-Item Correlations	Part 1	.000	1.738E+30	.000	1[a]			
	Part 2	.000	1.738E+30	.000	1[b]			
	Both Parts	.861	.861	.000	2	.661	.000	.791

a. The item is: Scores
b. The item is: Group

The reliability index is 0.791

APPENDIX G

Summary of Jigawa State Senior Secondary School Two (SSSII) Qualifying Examination Results for Chemistry (2013 -2014):

S/N	Year	No. of students sat for the Examination	No. Pass at credit level	% Pass at credit level	No. Fail	% Fail	Total
1.	2013	856	339	39.6	517	60.4	100
2.	2014	706	379	53.7	327	46.3	100
	Total	**1562**	**718**	**46.0**	**844**	**54.0**	**100**

Source: Monitoring and Evaluation Division of Jigawa State Education Resource Department (2017)

APPENDIX H

Summary of SS Two Chemistry Students by Educational Zones

S/N	EDUCATIONAL ZONE	LOCATION	SS2 CHEMISTRY STUDENTS ENROLMENT
1.	Hadejia Zonal Office	Hadejia	1785
2.	Gumel Zonal Office	Gumel	1348
3.	Ringim Zonal Office	Ringim	1615
4.	Jahun Zonal Office	Jahun	670
5.	Kafin Hausa Zonal Office	Kafin Hausa	400
6.	Birnin kudu Zonal Office	Birnin kudu	1511
7.	Birniwa Zonal Office	Birniwa	125
8.	Dutse Zonal Office	Dutse	571
9.	Kazaure Zonal Office		1332
Total			**9357**

Source: Monitoring and Evaluation Division of Jigawa State Education Resource Department (2017)

APPENDIX I

PRE-TEST ANOVA RESULT OF ABPT INSTRUMENT

Descriptive statistic for pre-test score

Teaching Methods	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Cooperative	88	44.0114	12.86937	1.37188	41.2846	46.7381	16.00	67.00
Laboratory	103	44.1553	13.38770	1.31913	41.5389	46.7718	15.00	67.00
Lecture	113	44.7080	13.80520	1.29868	42.1348	47.2811	16.00	66.00
Total	304	44.3191	13.35774	.76612	42.8115	45.8267	15.00	67.00

ANOVA

Performance

Groups	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	28.183	2	14.092	.078	.925
Within Groups	54035.866	301	179.521		
Total	54064.049	303			

APPENDIX J

FIELD-JIGSAW COOPERATIVE MODEL (FJCM)

Based on the relevance and suitability of cooperative learning strategy in teaching and learning, the researcher suggested that teacher and researchers should employ the use of FJCM in order to enhance performance and retention as well as wider coverage of the syllabus within the stipulated time scheduled for lessons. The model is presented in stages as follows:

Stage one: Formation of field-jigsaw heterogeneous groups in the classroom.

Stage Two: Assigning task to groups in line with the topic/sub-topics on the concept to be treated.

Stage Three: Get and brief the research assistants, and attach them to various expert groups.

Stage Four: Formation of the expert groups by the members of the field-jigsaw main groups.

Stage Five: Expert groups move to the field (accompany by research assistants).

Stage Six: Explanations, demonstrations/discussions led by local craftsmen, engineers/ technicians or experts related to the topic.

Stage Seven:Expert groups meet to discuss and write a comprehensive notes/reports based on what they have learnt at the field.

StageEight: Reports of the expert groups to be submitted to the teacher.

Stage Nine: Teacher observe the reports and make possible inputs in line with the course outline.

Stage Ten: Expert groups' members move back to their field-jigsaw main groups and make their presentations.

Stage Eleven: Evaluation is prepared and conducted by the teacher.

However, these activities are categorized into classroom activities (prior to field activities), actual field activities and classroom activities (after the actual field activities).