EFFECTS OF INQUIRY METHOD ON ACADEMIC PERFORMANCE OF CHEMISTRY STUDENTS IN SENIOR SECONDARY SCHOOLS IN KADUNA STATE, NIGERIA

BY

LUCY OMOKAADEJO

DEPARTMENT OF EDUCATIONAL FOUNDATIONS AND CURRICULUM,

AHMADU BELLO UNIVERSITY, ZARIA

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BY

Lucy Omoka ADEJO, B.Sc. (Ed) CHEMISTRY,

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MARCH, 2015

DECLARATION

I hereby declare that the work in this thesis entitled"Effect of inquiry method on Academic performance of Chemistry students in Senior Secondary Schools in Kaduna State"has been carried out by me in the Department of Curriculum and Instruction. 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.

_____ _____

LucyOmoka ADEJO **Date**

CERTIFICATION

This thesis entitled **"EFFECTSOF INQUIRY METHODON ACADEMICPERFORMANCE OFCHEMISTRYSTUDENTS INSENIOR SECONDARY SCHOOLS INKADUNA STATE''** by LucyOmoka ADEJO meets the regulations governing the award of the degree of Masters in Curriculum and Instruction of AhmaduBello University, and is approved for its contribution to knowledge and literary presentation.

_____ _____

Dr. H.O. Yusuf **Date**
Chairman, Supervisory Committee

_____ _____

Dr. A. Guga **Date**
Member, Supervisory Committee

_____ _____

Dr. B.A.Maina **Date**
Head, Department of Education

_____ _____

Prof. A.Z Hassan **Date**
Dean School of Postgraduate Studies

D**EDICATION**

This research work is dedicated to mybeloved husband, Mr. AdejoDaniel and my children, Owoicho'Oche,Owoich'Oyare and Ebok'Owoicho.

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ABSTRACT

The study examined the effects of guided Inquiry method on academic performance of chemistry students in selected senior secondary schools in Kaduna state. The study used a quasi-experimental research design.A sample of 120 senior secondary 11 (SS2) chemistry students were selected by random sampling from 2 urban and 2 rural schools which comprised both boys and girls with 30 students each in experimental and control groups respectively. The research instruments comprised of chemistry Achievement Test (CAT). The CAT contained 30 multiple choice questions with four options (A-D) and 5 essay questions. The students were divided into two groups; Experimental and control groups which were subjected to inquiry method and traditional methods of teaching respectively. The t-test statistics was used to analyze the data. Major findings revealed that Chemistry students taught using inquiry teaching method performed significantly better than their counterparts taught using traditional teaching method. Hence the study concluded that the inquiry teaching method produced students with significantly higher academic performance inChemistry. The study therefore recommend among others that the use of Inquiry teaching method should be encouraged in all Secondary Schools that offer Chemistry to its students in Kaduna State and other states in Nigeria, also Government should sponsor teachers to attend various workshops and seminars on appropriate and effective use of the inquiry teaching method.

OPERATIONAL DEFINITION OF TERMS

Effects: As used here, means a noticeable impact of methods on the teaching and learning in Senior Secondary Schools.

Performance: means what you get out of an activity performed by students for what they put in . It is a measurement in terms of specific and desirable results in examination.

Inquiry: Is any process used for finding the solution to problems by learners with assistance from the teacher.

Chemistry: This is a core science subject offered in senior secondary schools and deals with the Scientific study of the composition, structure, properties and change of matter in which Studentsmust have a credit in order to get admitted into the higher institutions of learning.

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CHAPTER ONE
INTRODUCTION

1.1 Background to the Study

Chemistry is the scientific study of interaction of chemical substances that constitute atoms or the subatomic particles; protons, electrons and neutrons. It is an integral part of the science curriculum both at the senior secondary school as well as higher institutions. At this level, it is often called “general chemistry” which is an introduction to a wide variety of fundamental concepts that enables students to acquire tools and basic skills useful at the advanced level. One of the objectives of science education is to develop students’ interest towards science and technology. The development of any nation today depends greatly on its technological and scientific advancement. Teachers are expected to device ways of motivating their students to develop positive attitudes towards science and science related disciplines (Sola and Ojo, 2007). Chemistry, in particular is central to many of the scientific fields of human endeavors; therefore, teaching ofchemistry should be given serious attention.

Science teachers have always recognized the importance of practical work as a means of introducing learners to the scientific process of experimentation.To this end, the United Nations Educational Scientific and Cultural Organization (UNESCO) and the International Union of pure and Applied Chemistry (IUPAC) have participated in numerous international meetingsto promote inexpensive experimental based teaching in chemistry. Inquiry teaching method is a style or method of teaching where the learner is seeking to discover and create answers to recognized problems through procedure of making a diligent search, some time with minimum guidance from the teacher (Callahan, et *al* 1995). Science process skills are based on scientific inquiry and teaching science by inquiry involves teaching students science process skills, critical thinking, scientific reasoning skills used by scientists (Pratt and Hackett, 1998) and inquiry is defined as an

approach to teaching, the acts scientists use in doing science and it can be a highly effective teaching method that helps students to understand concepts and use of process skills (Yagger and Akcay, 2010). Inquiry teaching method is also a term used in science teaching that refers to a way of questioning, seeking knowledge, information or finding out about phenomena, it involves investigating data and arriving at a conclusion (Sola and Ojo, 2007). In inquiry situation students learn not only concept but also self-direction, responsibility and social communication. It also permits students to assimilate and accommodate information. It is the way people learn when they are left alone.

Cheval and Hart (2005), classify inquiry teaching method into three (3) classes, namely: structured inquiry, guided inquiry and open inquiry. All these types of inquiry can be useful to students to learn science when taught appropriately. Structured inquiry is the most teacher-centered of the three types of inquiry. This type of inquiry is commonly seen in science classrooms in the form of laboratory exercises. The teacher provides fairly structured procedures for the inquiry activity, and students carry out the investigations. Structured inquiry could be described as the most traditional approach to inquiry (Cheval and Hart, 2005). The open inquiry on the other side is a type of inquiry which requires the least amount of teacher intervention and is student centered. Students, in this case, often work in groups and plan all phases of their investigations, while guided inquiry falls in the middle of the inquiry instructional spectrum. This type of inquiry is commonly used when students are asked to make tools or develop a process that results in a desired outcome. For example, a science teacher gives his seventh grade middle school students materials to create a rocket but no instructions for designing the rocket. The students must use their own knowledge and creativity to design the rocket so that it will launch properly, fly a certain distance, and land without becoming disassembled. The teacher provides the problem and materials and the students develop the rocket using their own scientific process or procedure (Cheval and Hart,

2005). In this study, guided inquiry will be used. Students will be given a set of topic and materials to develop method to find answers to the given problem. The lecture method is used primarily to introduce students to a new subject, but is also a valuable method for summarizing ideas, showing relationships between theory and practice, and re-emphasizing main points.Chemistry activities deals with telling and showing, therefore, a lecture-demonstration method is a teaching technique that combines oral explanation with “doing” to communicate processes, concepts and facts. It is particularly effective in teaching a skill that can be observed.

Demonstration is usually accompanied by a thorough explanation, which is essentially a lecture. Lecture method according to Garba(1996), is a traditional method of transmission of knowledge; it is essentially a one-way process. The current Nigerian classroom whether primary, secondary or tertiary institutions level, tends to resemble a one-person show with a captain but often comatose audience. Classes are usually driven by “teacher-talk” and depend heavily on textbooks for the structure of the courses. Teachers serve as pipelines and seek to transfer their thoughts and meanings to passive students. There is little room for student-initiated questions, independent thought or interaction between students. Therefore, the study is aimed at determining the effect of guided inquiry teaching strategy and the traditional methods on students’ academic performance in chemistry at the senior secondary school level. Guided Inquiry teaching method is chosen in this study due to its scientific nature and it is student-centered and it involves all scientific process.

1.2 Statement of the Problem

Students’ persistent poor performance in chemistry has been partly ascribed to inadequate teaching and instructional methods adopted by teachers. In supporting this view, Derek (2007), reported the seriousness of the deplorable performance of

secondary school students in chemistry and identified the persistent use of the traditional methods of instruction as one of the major shortcoming affecting the learning and higher achievement in chemistry . Many students find chemistry to be a hindrance in attaining their aims and objectives. Donald, (2000) said students wishing to read medicine cannot do so unless they credit chemistry. It is therefore necessary to properly groom the students right from the secondary level to enable them improve their academic achievement in chemistry. Poor performance of students in science subjects, particularly chemistry, has assumed a serious dimension as reported by West African Examination Council (1991). In the light of this, science teachers need to seek suitable ways of tackling the current massive failure in chemistry if they are to halt the drifts of science students to art and social science subjects.

1.3 Objectives of the Study

The objectives of this study are to:

1. determine the effects of guided inquiry method and traditional method on the performance of chemistry students in senior secondary schools in Kaduna state;
2. determine the effects of guided inquiry method on the performance of students in chemistry in Kaduna state;
3. determinethe effects of guided inquiry method on theperformance of male and female students in chemistry in Kaduna state; and
4. determine the differencein the performance between urban and rural students in chemistry taught with guided inquiry teaching method in Kaduna state.

1.4 Research Questions

1. What is the effect of guided inquiry method and traditional method on the Performance of students in chemistry in senior secondary schools in Kaduna state?

2. What is the effect of guided inquiry method on the academic

Performance of students in chemistry in Kaduna state?

3. What is the effect of guided inquiry method on the performance of male and female students in senior secondary school in chemistry Kaduna state?

4. What is the difference in the performance of students in chemistry in senior secondary schools taught with guided inquiry teaching method in Kaduna state?

1.5 Null Hypotheses

The following null hypotheses were tested:

Ho_1: Guided inquiry methodand traditional method have no significant effect on the performance of chemistry students in senior secondary schools in Kaduna state;

Ho_2: There is no significant effect of guided inquiry method on the academic performance of chemistry students in Kaduna state;

Ho_3: Guided inquiry method hasno significant effect on the performances of male and female studentsin chemistry in Kaduna state;

Ho_4: There is no significant difference in the performance between urban and rural students taught chemistry with guided inquiry teaching method in Kaduna state.

1.6 Basic Assumptions

This study has the following assumptions

1. It is assumed that most chemistry teachers in the secondary schools do not make use of appropriate chemistry teaching methods in secondary schools in Kaduna state.

2. It is also assumed that teachers are employed to teach Chemistry without considering their area of specialization, educational qualifications and training.

3. It is assumed that teachers do not use appropriate Chemistry teaching methods.

4. Learning by doing could enhance and motivate students to improve on their performance in chemistry.

1.7 Significance of the Study

The findings of this study will help in the following ways:

The chemistry teachers will utilize the findings of this study in their chemistry classrooms; helping students' understanding of chemistry concepts through guided inquiry teaching method. Students at the senior secondary school (SSS) level in Kaduna state and other states can be encouraged and motivated by this research.Active involvement of students helps to develop self-confidence and positive attitude to chemistry through this research.The study will provide information for educational planners and curriculum designers in the Federal Ministry of Education. They will support the use of inquiry teaching method in senior secondary schools by carrying out effective quality assurance for teachers in order to improve teaching/learning situations currently existing in senior secondary schools in Kaduna state.

It is hoped that the students will find Chemistry very interesting as it will equip them for job opportunities in industries in both private and public sectors such as manufacturing and processing industries, industries related to petroleum, chemical,

ceramic, polymer, food, electronics, the environmental, mining, pharmaceuticals and health- related industries, agriculture industries, government agencies, including forensic science and patents, defence, education and research, and areas related to biotechnology.

1.8 Scope of the Study

Thisstudy on Effects of guided inquirymethod on academic performance of chemistry studentsis delimited to senior secondary schools in Sabon/gariand Zaria local government areas of Kaduna state, Nigeria. The study involves senior secondary two (SS2) chemistry students with a total population of five thousand, nine hundred and thirteen (5,913).It is delimited to a consideration of the effects of inquiry method on students' performance in chemistry in Kaduna state.

CHAPTER TWO
REVIEW OF RELATED LITERATURE

2.1 Introduction

Science and Technical Education is the factory for production of needed technologists, technicians and crafts men as well as skilled artisans who are required to turn the nation's economy for the better and usher in the desired technological advancement which is very much required for the elevation of Nigeria from a consumer nation to a producer nation, from a developing nation to a developed nation (Avaya, 2007). Acquisition of appropriate scientific and technological skills is necessary to cope with the challenges presented by the evolving needs of modern workplace in our industries and the ever growing non-formal sector. This study investigates the effects of two teaching methods on academic performance of secondary school chemistry students in Kaduna state. This chapter discusses the literature review under the following headings: theoretical framework, chemistry education, chemistry in everyday life, the Concept of separation of mixtures, Instructional strategies in the teaching of chemistry, An overview of traditional method, The Concept of performance, Academic performance in chemistry, Students' attitude and performance in chemistry, Attitudes of students towards chemistry and Instructional strategies, Factors affecting students' performance in chemistry, Reasoning and thinking conditions for better performance in chemistry and Empirical studies.

2.2 Theoretical Framework

A theory is an explanation, idea or opinion based on thought, observation and reasoning which have been tested and confirmed as general principle explaining a large number or related facts (Yamah, 2009). According to Alkali (2009), theories are ideas, facts and principles that can be best used to describe a given concept. On this note, this

research work recognize the principles behind the Chinese maxim; “I hear and I forget, I see and I remember, I do and I understand.” This explains that learners must be active not passive in any teaching situation to maximize learning.The underlying philosophy of this study is based on the theories of cognitive science particularly that of John Dewey theory of constructivism.

2.2.1 John Dewey theory of constructivism

Constructivism theory is about how we come to know what we know. It is founded that children, adolescents, and even adults construct or make meaning about the world around them based on the context of their existing knowledge (Llewellyn 2005), constructivism theory provides a framework through which the emergent ideas about teaching, learning and assessment can be unified (young and Collins, 2003). According to this theory, the difficulty and challenges confronting classroom teachers is that the reform strategies in curriculum, instruction and assessment organized around the theory of “constructivism” are informed by different assumptions and about the nature of knowledge and about the human capacity to learn than are traditional classroom practice (Kim, 2005).

Constructivism is a psychological theory of knowledge which argues that human construct knowledge and meaning from their experiences. This theory lays emphasis on not accepting what you are told but your prior knowledge about what you are taught and your perceptions about it. Active involvement of students is emphasized in constructivism, hence knowledge gained last long in their memory. Emmanuel Kant further elaborated this idea by asserting that human beings are not passive recipients of information. Learners actively take knowledge, connect it to previously assimilated knowledge and make it theirs by constructing their own interpretation (Cheek 1992). According to (Mahoney, 2004), students come into a classroom with their own

experiences and a cognitive structure based on those experiences. These preconceived structures are valid, invalid or incomplete. The learners will reformulate his/her existing structures only if new information or experiences are connected to knowledge already in memory. Inferences, elaboration and relationship between old perceptions and new ideas must be personally drawn by the student in order for the new idea to become an integrated useful part of his/her memory. Memorized facts or information that has not been connected with the learner's prior experiences will be quickly forgotten. In short, the learner must actively construct new information onto his/her existing mental framework for meaningful learning to occur. Inquiry teaching method is an activity-based teaching method, which involves the students in the learning process, placing less emphasis on transmitting knowledge and more on developing students' science process skills. Based on this fact, it is assumed that inquiry teaching method which is an activity-based method will aid better learning in chemistry.Vonglaserfeld (1989), pointed out that the responsibility of learning should reside increasingly with the learners where they are actively involved in the learning process-unlike previous educational view point where the responsibility rested with the instructor to teach. In a constructivist the role of the teacher is to organize information around conceptual clusters of problems,questions and discrepant situations in order to engage the student's interest. Teachers assist students in developing new insights and connecting them with their previous learning. Ideas are presented holistically as broad concepts and then broken down into parts.The activities are student-centered and students are encouraged to ask their own questions,carrying out their own experiments, make their own analogies and come to their own conclusions (Vonglaserfeld, 1989). Cognitive theorists believe the role of the teacher is to provide learners with the opportunities and incentives to learn, holding that among other things:

1. All learning,except for simple rote memorization, requires the learners to actively construct meaning.

2. Students'prior understandings and thoughts about a topic or concept before instruction exert a tremendous influence on what they learn during instruction.

3. The teacher's primary goal is to generate a change in the learner's cognitive structure or way of viewing and organizing the world and

4. Learning in co-operation with others is an important source of motivation, support,modeling, and coaching (Feden, 1994).

The constructivist theory of learning supports cognitive pedagogy, that humans have an innate sense of the world and this domain allows them to move from passive observers to active learners. Carlson (2003), supports a strong emphasis on identifying, buildingupon and modifying the existing knowledge (prior knowledge) students bring to classroom, rather than assuming they will automatically absorb and believe what they read in the textbook and are told in the classroom method which actively involves the students is what Constructivist emphasized in it teaching approach, hence knowledge gained last long in their memory, since human being are not passive recipients of information. Traditional teachers are information givers and textbook guided classroom has failed to bring about the desired outcome of producing thinking students (Young and Collins, 2003). Amuch heralded alternative is to change the focus of the classroom from teacher dominated to student centered.Using a guided inquiry method based Constructivism is not accepting what you are told but your prior knowledge about what you are taught and your perception about it.Active involvement of students is emphasized in Constructivism, hence knowledge gained last long in their memory. Yeager (1991), attested to the fact that 'one only knows something if one can explain it'

Learners actively take knowledge, connect it to previously assimilated knowledge and make it theirs by constructing their own interpretation (Cheek, 1992).

2.3 Chemistry Education

Chemistry education has been identified to be one of the major bedrock for the transformation of our natural economy and hence must be accorded adequate attention. It was as a result of the recognition given to chemistry in the development of individual and the nation that it was made a core subject among the natural sciences and other science related courses in Nigeria education system (Adesoji, 2008). Chemistry has been a prerequisite subject for offering most science oriented courses in the tertiary institutions and these calls for the need of teaching it effectively (Adesoji, 2008). Chemistry teaching is supposed to be result oriented and can only be achieved when students are willing and teachers are favourably disposed, using the appropriate method and research in teaching the students (Adesoji, 2008). 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. It is only by personalizing such knowledge that it becomes valid, meaningful and useful to them. In chemistry, students need to actively construct their own personal awareness and meanings (Usman, 2000). To substantiate this, Usman remarked that the brain is not a passive consumer of information and to learn with understanding, a learner must actively construct meaning of what is learnt (Usman, 2006).

2.4 Chemistry in Everyday Life

Chemistry is one of the three main branches of pure science, the other two being, Biology and physics. Chemistry deals with the composition of matter and the changes matter undergoes. The world is made up of matter, we study chemistry to

acquire and learn the skills of observation, recording and making an intelligent conclusion from our observation. Studying chemistry gives us training in scientific method and the knowledge of chemistry helps us to become scientists. Those that are trained in chemistry are known as chemists (Bashir, 2005).

Chemistry helps in improving the quality of our life today (Ibrahim, 2006). Studying chemical processes around us, such as lightening a match, cooking; burning of fire wood, rusting nails and so on allows man to understand his environment and possible changes it may undergo under different conditions (Sola and OJo, 2005). All the household materials, such as soap and detergents for washing, hair creams and perfumes and majority of cooking utensils, plastic materials for wide variety of uses are all products of chemical process, (Wong *et al*, 2002).

Chemistry contributes towards providing our basic needs and improving the quality of our life in the following areas:

a. Agriculture; production of different type of fertilizers and insecticides have been possible by chemical means, these increase food production greatly. The preservation andstorage of food for long period is made possible as a result of chemicals prepared by chemists and also by means of chemical process, so that the food can be exported to distant places and made available to more people, to tight hunger and malnutrition. Many food substances today are enriched by addition of essential nutrients, (Wong *et al*, 2002).
b. Man-made textile fibers products are as a result of intensive chemical researches has made available a wide range of clothing materials; this supplements the scarce natural fibers. Building materials such as cement, steel, bricks and tiles are produced by chemical industries. The chemical researches

and these properties can be modified through chemical reaction to suite a certain purposes, (Wong *et al*, 2002).

c. The healthy life many of us are enjoying today is due to the variety of medicines that are available as a result of advanced chemical researches in chemistry. These researches are financed by pharmaceutical firms, governmental and non-governmental organizations and are conducted by chemists. These researches will contribute to discover new drugs and also meet the challenges of time, and

d. Career in chemistry, Nigeria is a developing nation with an increasing demand for skilled man power. Many job opportunities are available for students with knowledge of chemistry in the public and private sectors, these opportunities are more prevailing in the following areas:Teaching services, chemistry teachers and lectures in secondary schools, polytechnics, college of education and universities, laboratory assistants in schools and universities, nurses, medical assistants and laboratory assistants are all students of chemistry, that is to say, they must have studied chemistry before being what they are (Garba, 2006).

2.5 Concept of Separation Techniques

All matter can be classified as either mixtures or pure substances. It is therefore expected that students should study the properties of matter and how matter can change from one form to another. Through their study of mixtures and solutions, students will further refine their understanding of matter. The study of matter enables

students to explore and develop an appreciation of how various types of matter are important in their daily lives and will be introduced to several techniques for separation of mixtures into their constituent parts.However, students are being encouraged to identify and explore the variety of mixtures and pure substances they use or encounter in their daily lives. In particular, mixtures are so common in our lives that they are virtually "transparent" in our daily experience (Wilson *et al,* 2000).

Students should be encouraged to explore the variety of mixtures that are important in our lives and to investigate how separating these mixtures into their constituent parts provides other valuable or important substances on which we depend.In chemistry and chemical engineering, a separation process, or simply a separation, is any mass transfer process that converts a mixture of substances into two or more distinct product mixtures, at least one of which is enriched in one or more of the mixture's constituents (Wilson et al, 2000). In some cases, a separation may fully divide the mixture into its pure constituents. Separations are carried out based on difference in chemical properties such as size, shape, mass, or chemical affinity between the constituents of a mixture, and are often classified according to the particular differences they use to achieve separation. In case that no single difference can be used to accomplish a desired separation, multiple processes will often be performed in combination to achieve the desired end. Barring a few exceptions, almost every element or compound is naturally found in an impure state. Often, these impure raw materials must be separated into their purified components after they can be put to productive use, making separation processes essential for the modern industrial economy. In some cases, these separations requires total purification, as in the electrolysis refining of bauxite ore for aluminum metal, but a good example of an incomplete separation process is oil refining (Wilson et al, 2000).

2.5.1 Separation of Mixtures techniques

The different substances in mixtures are usually easily separated from one another; the method used depends upon the type of mixture. There are different types of separation of mixture technique as outlined by free chemistry online, 2014:

1. **Chromatography**: This is good for separating dissolved substances that have different colours, such as ink and plant dyes. It works because some of the coloured substances dissolve in the liquid better than others, so they travel further up the paper.
2. **Filtration:** This is good for separating an insoluble solid from a liquid (an insoluble substance is one that does not dissolve). Sand, for example, can be separated from a mixture of sand and water using filtration. That's because sand does not dissolve in water.
3. **Evaporation:** This is good for separating a soluble solid from a liquid (a soluble substance dissolve, to form a solution).For example, copper sulphate crystals can be separated from copper sulphate solution using evaporation. Remember that it is water that evaporates away, not the solution.
4. **Simple distillation:** This is good for separating a liquid from a solution. For example, water can be separated from salty water by simple distillation. This method works because the water evaporates from the solution, but is then cooled and condensed into a separate container. The salt does not evaporate and so it stays behind.
5. **Fractional distillation:** This is good for separating two or more liquids from each other. For example, ethanol (alcohol) can be separated from a mixture of ethanol and water by fractional distillation. This method works because the two liquids have different boiling points.

6. **Sedimentation and decantation:** This is a process of separating an insoluble solid from a liquid in which it is suspended by allowing it to settle to the bottom of the container. If this also involves pouring off the liquid leaving the solid behind, it is called decantation.
7. **Crystallization:** This is a sophisticated form of evaporation technique in which crystals of the solute are encouraged to develop during the process of "dissolving out" from the solution as the solvent evaporates.
8. **Sublimation:** This is a process in which some solids, on heating, are transformed directly to vapour without passing through the liquid phase, and vice versa. This technique can be used to separate a mixture of solids, one of which can undergo sublimation. The vapour is then cooled separately to get the sublimed solid back. Sublimation is used in the separation of substances like ammonium chloride, iodine, naphthalene, camphor and sulphur.

9. Extraction: In some cases, one substance in the mixture is soluble in a particular liquid solvent whereas the other(s) is (are) insoluble in it. The process of dissolving out the soluble component from a mixture, and subsequently treating the solution to get the solid, is called extraction.

10. Magnetic separation: This method of separation is exemplified by the separation of iron filings. A mixture with iron fillings as one of the components can be separated using a magnet to attract the iron particles away from the mixture, and

11. Gravity separation (separating funnel): In gravity separation, a mixture of two immiscible liquids can be separated using a separating funnel, the working of which is based on the differences in the drained out first from below the funnel into a beaker, and then the lighter liquid is drained out in another beaker.

2.6 Acid, Base and Salts Concept

Acid (from the Latin acidus meaning sour) is traditionally considered to be any chemical substances that when dissolved in water gives a solution with high concentration hydrogen ion activity greater than that of pure water i.e. a PH less than 7.0 (Wikipedia, 2009). According to Wikipedia (2009) an acid is defined as a compound that donates hydrogen ion (H+) in solution to another substance called base. Common examples of acids include acetic acid in vinegar and sulphuric acid used in car batteries. A base is a substance that accepts hydrogen ion from an acid or it is a substance that increases the concentration of hydroxyl in solution (OH-) Blair, (2005). Examples of bases include sodium hydroxide used in the manufactureof soap, sodium salt and plastics, potassium hydroxide used in the manufacture of dying and in electroplating. Salts are compounds formed when all or parts of ionisable hydrogen ions from an acid have been replaced by metal or ammonium ion. There are five main types of salts: normal salt, acid salt, basic salt, double salt and complex salt. Normal salts are formed when all the replaceable hydrogen ion in the acid have been completely replaced by metallic ions. Example includes sodium tetraoxosulphate (IV) Na_2SO_4. Acid salt is formed when parts of replaceable hydrogen ions are partially replaced by metal;example is potassium hydrogen sulphate ($KHS0_4$). Basic salts are salts containing hydroxide ion OH- (Bashir, 2005). They are formed as a result of insufficient supply of acid which is needed for complete ionization of the base (Zn(OH)Cl). Double salts are salts which when ionized produced three different type of ions, in which two are positive (metal ions or ammonium ions) while the other is a negative ion. Complex salt containing complex ion consists of group charge atoms e.g. Sodium tetrahydroxozincate (II) Na_2ZnOH_4.

In this study, concepts of separation technique, acid, base and salts were used to investigate the effectiveness of inquiry teaching method on academic performance.

2.7 Chemistry Learning and Retention

Permanent and meaningful learning is the target of any educational endeavor. Understanding and retention are the products of meaningful learning when teaching is effective and meaningful to the students (Bichi, 2002). Retention is defined as the ability of one to remember what he has learned in the later time, it takes place when learning is coded into memory. Thus appropriate coding of incoming learning, or incoming information provides the index that may be consulted; so that retention takes place without elaborate search ability retains and consequently remembers what we have experienced, or what we have in memory (Oyedokun, 1998).

There are several factors that influence retention. According to Blair and Simon (1998), anything that aids learning should improve retention while things that lead to confusion, or interference among learning materials decreases the speed and efficiency of learning and accelerates forgetfulness. Interference may exist in several forms such as retroactive inhibition, or emotional inhibition. Retroactive inhibition results when things are learned, the result of that leaning usually occurs after a passage time. In the intervening period, many other things are learned. These interpolated learning interfere with the memory of the original materials and the interference is known as retroactive inhibition (Blair & Simon 1998).

According to Paul (1999), retention is based model for which the meaningful stimuli are processed by the brain at a deep level. This model is attributed to the long time memory (retention) which is based on our ability to process semantic knowledge deeply by associating recall items. (Blair & Simon 199) conducted an experiment on the effect of traditional learning method in teaching two sections of an undergraduate course on the retention; he discovered that those students taught using inquiry method had better retention ability than those taught with traditional lecture method.

2.8 Instructional Methods in the Teaching of Chemistry

Different methods and strategies have been suggested for involving students in lessons and engaging them in active learning (Trowbrigde (2000); Deboer, 2002; Goodrum, 2002). However, in order for any method to be successful, effective lesson planning is essential (Henson and Eller, (1999); Harlen 1999). The planning process involves clarification of the roles of the teacher and students. Thus, it makes easier for students to follow the teacher's guide and encourages them to participate more in the lesson and take responsibility for their own learning (Good and Brophy, 1994; Calderon *et al*, 1996). For this reasons, effective lesson planning has a positive effect on students' learning. (Brown, 1994; Tomic, 1994; Glenng, 2001).

A guided Inquiry teaching method revolves around students learning through 'hands-on minds-on' activities. Instructional approaches that been shown to be effective for improving student performance in science are active learning strategies.Some of these strategies include inquiry method, traditional (lecture) method,and problem solving approach, cooperative learning and project method among others.

Guided Inquiry teaching method has been described as problem solving, critical thinking, reflective inquiry, deductive thinking and not mere personal assumptions. It is a method of teaching that involves probing, finding out, investigating, analyzing, synthesizing, discovering, evaluating, questioning and thinking (Muhammad, 2007). Guided inquiry teaching method allows students/pupils to engage in experimentation similar to that of real scientists. Through these activities of inquiry, teachers can encourage their students to expand their critical thinking skills and use their logic to derive answers to scientific quandaries.

Teaching methods such as inquiry teaching, problem solving, problem based learning and project based learning relies heavily on the effective use of the science process skills by students to complete an investigation (Colley, 2006). The method is based on the assumption that the subject is to be learnt actively by fully participating in the learning task. It is a method that leads to effective learning outcome thatismeaningful to the learner (Muhammad, 2007). For the students to meaningfully engage in aninquiry there is need for the teacher to practically involve the students from the planning stage to the evaluating stage. This could be done or achieved by the students and the teacher in locating and gathering information from many sources like reading materials, specimens and community resources.

From a science perspective, inquiry-based science teaching engages students in the investigative nature of science. Inquiry involves activity and skills, but the focus is on the active search for knowledge or understanding to satisfy a curiosity. According to Ketpichainarong (2009), inquiry teaching and learning methods affect student's performance, for example in solving problems, reflecting on their work, drawing conclusions, and generating prediction. These qualities are necessary for high- achieving students. Inquiry teaching method is one way of making sense out of what we experienced and therefore requires thinking, (Blair and Simon 1998). This implies that the method requires putting learners into a situation in which they must be engaged in intellectual operation that constitutes finding out.

Kyle and Gadsden (1996), viewed an inquiry teaching method as a strategy of teaching where students examine ideas, existing issues, and probe and question them freely, and practice on their own or with little guidance from the teacher. Here, the students seek for information to answer or solve their problems. Therefore, inquiry teaching is educative and experimental and produces a lot of fun and joy as students

learn by doing. When children are engaged in doing some activities, it simply means that their hands are on the activities, the type of activities where they are manipulating, observing, exploring, and thinking about science using concrete materials. Therefore, teachers, regardless of grade level, should promote inquiry-based instruction and provide classroom environments and experiences that facilitate students' learning of science.

An ancient Japanese proverb says; "give a man a fish and he will not be hungry for a day, teach a man how to fish, he will not be hungry for a life, (Mathias, 1973). By this proverb, it means that teaching people how to tackle and solve problems by themselves become an asset which is what the inquiry approach stands for, while solving problems for people, which is what traditional lecture method is known for, is temporary. Scientific inquiry is a powerful way of understanding science content. Students learn how to ask questions and use evidence to answer them. In the process of learning the strategies of scientific inquiry, students learn to conduct an investigation and collect evidence from a variety of sources, develop an explanation from the data, and communicate and defend their conclusions. The use of inquiry method will help to ensure that students develop a deep understanding of science and scientific inquiry (NSTA 2011). Teaching chemistry through inquiry is not just providing hands-on activities for students,it is more. It is designing experiments and talking about it. It is reporting on their investigations, reflecting, and making and communicatingself-assessment. This differentiation of hands-on activities and student driven investigations with dialogue makes inquiry learning much more than hands-on science. Kyle and Gadsden (1996).

Although, the inquiry teaching method has been described by many educationists as effective approach, it is not without some shortcomings and many

people have expressed one thing or another against the inquiry teaching method. One of such critiques is Bredderman (1985) who pointed out some disadvantages of inquiry approach to include its time consuming nature. Much time is needed to plan inquiry activities. It may not be possible to use the inquiry approach in all situations and some authors like Agboola and Oloyede (2007) maintained that, inquiry approach is more suitable for "intuitive and creative children who are full of enthusiasm and active". German (1989), in his own view concerning the competency of the teacher, said; "if the method is used by a competent teacher, it has great deal to offer but if used incompetently as fashion, it is probably more disastrous to learning than exclusive reliance of the former methods.

Many different methods and strategies have been suggested for involving students in lessons and engaging them in active learning (Trowbridge 2000; Deboer, 2002; Goodrum, 2002). However, in order for any method to be successful, effective lesson planning is essential (Henson and Eller, 1999; Harlen, 1999). A lesson plan requires teacher to be clear about the sequence of the activities in the lessons, the purpose and goals of the lessons, the planning process involves clarification of the roles of the teacher and students. Thus, it makes easier for students to follow the teacher's material and encourage them to participate more in the lesson and take responsibility for their own learning (Good and Brophy, 1994; Calderon *et a*l, 1996). For these reasons, effective lesson planning has a positive effect on students' learning (Brown, 1994; Tomic, 1994; Glenng, 2001). Moreover, according to the above, teachers should allow some flexibility in lesson planning in order to encourage students to participate more in the lessons. A rigid lesson plan potentially hinders active learning by preventing students from being involved in the lesson. Other strategies and methods include;

Role-playing: This can also be a useful teaching and learning activity to encourage students to participate more in the lessons and facilitate their understanding. In role playing strategy, students are given a chance to play the role of teacher. It is a dramatic method. However, researchers report that role-playing in science lessons is underrated and under-used, often because of misconception about what role-play is and how it can be put to use in science education (Resnick and Wilensky 1998). They pointed out that the theory behind the use of role-play in science teaching and learning supports 'active', 'experimental' or 'student-centered' learning.

Therefore students are encouraged to be physically and intellectually involved in their lessons to allow them to both express themselves in a scientific context and develop an understanding of difficult concepts. In role-playing method, the teacher teaches the topic and the students one by one teaches the same topic to the class. When he teaches, all his classmates answer his questions. They note down the shortcomings of the student- teacher. This teaching is later criticized and suggestions for improvement are given.The subject teacher is advised to be present in the class at the time of role play. He should be there in the class at the time of criticism. The topic of teaching for the purpose of role playing should be the same for all the purposes of comparison. The assumption of this method of teaching is that a group of pupils can give more ideas than a single person. Problem can be analyzed and evaluated more comprehensively.

Cooperative learning is another teaching strategy which provides opportunities for students to develop skills in group interactions and working with others which is needed in today's world (Carol, 1988). According to Johnson and Johnson (1990), cooperative learning experiences promote positive attitude towards the instructional experience than competitive or individualistic methodologies. (Ibrahim, 2006) believes that students

are more likely to acquire critical thinking skill and meta-cognitive learning strategies, such as learning how to learn, in small group cooperative settings as opposed to lectures. Johnson and Johnson (1990), discuss various situations in which cooperative learning helps to create an environment where students are more inclined to question the concepts that appear unclear to them. Active learning (AL) methods includes group projects with class participation and hand on experiment. Other teaching strategies include interactive multimedia (IMM) which is a relatively new educational innovation. It is used in primary, secondary and tertiary level. Interactive multimedia is defined as a powerful combination of early technologies that constitutes an extraordinary advancement in the capability of machine to assists the educational process (Mohsen, 1998). Interactive multimedia combines computer hardware, software and peripheral equipment to provide a rich mixture of text, graphics, and sound animation to students.

The assumption that multimedia information facilitates learning process has led to an increasing use of IMM computer assisted instruction (Najjar, 1996). The interaction nature of multimedia makes it especially attractive in youth education because interactive encourages children to take an active role in learning process (Flowers, 1987). Research shows that children are much more attentive to programmes where animation and narrative are used (Najjar, 1996). Inquiry method of teaching enable students to interact with the learning materials and the students are responsible for their own learning.

2.9 Traditional Method

The traditional method is an oral (lecture) method of teaching, Bimbola, (2010). It is essentially a one way process of transmission of knowledge with the lecturer/teacher being active while the learners are passive. The current Nigerian classroom weather primary, secondary or tertiary institutions level tends to resemble a one- person show

with a captain but often comatose audience. Classes are usually driven by “teacher- talk” and depend heavily on textbooks for the structure of the course. According to Donald (2000), lecture method is the most frequently used method in teaching. However, presentation of lecturer without pausing for interaction with students can be ineffective regardless of the skill of the lecturer. The traditional method according to (Dianye and Gbamaja1990), is defined as a teaching technique in which one person usually presents a spoken discourse in a particular subject.

According to Bello (1981), the science teacher comes to the class fully with a mass of facts, he presents ideas or concepts, develops and evaluate them and summarizes the main points at the end while the students listens and take down notes. He also observed that students merely (absorb and absorb” scientific facts and factual memorization of discrete facts.Ezeh (2005) reaffirms that teachers have just taking to notes copying techniques after talk, these method at best emphasize the cognitive aspect of teaching only. The traditional approach to science teaching dominates chemistry classes. Studies by Bichi, (2002) and Mani, (1982) attested to the fact that most science teachers today in Nigeria employ the traditional method. The traditional expository method which is an old aged long traditional method of teaching in which knowledge or information are presented, conveyed or transferred to learners by the teachers who dominates the authoritarian teaching- learning process, talks as an autocrat, as a repository of knowledge to passive listening students who unquestionably see the teachers presentation as sacrosanct. The expectation is that the latter should be able on demand to regurgitate a role- memory stored knowledge presentation by the teacher (Mezieobi*et al,* 2008).Traditional method is characterized by a large class size which may range from 25-100. It is often used for highsecondary school students and tertiary institutions. It has the following characteristics:

i. The students are absolutely passive listeners and passively assimilating information given to them by the teachers.

ii. It may be supported with visual aids, films, lecture media and handouts.Students are responsible for making their own notes.

iii. It is teacher-centered; the teacher or the lecturer does the major activities, that is talking, illustrating or presenting the films, or other aids (Colburn, 2000).

iv. Traditional teaching is fully teacher- centered. In this paradigm, teacher is authoritative person and students are the passive recipients of information (Lecture, demonstration, Socratic and so on.) students are expected blindly to accept the information they are given without questioning the instructor (Stofflet, 1998). The teacher seeks to transfer thought and meaning to passive students leaving little room for student initiated questions, independent thought or interaction between students (Vast, 1998). Even the laboratory activities which are inclusive in chemistry that is usually done in a group, the traditional teacher dodge discussion or exploration of the concepts involved. The traditional method of exposition has this advantage. It saves time and energy in that the teachers cover a large amount of materials (syllabus) to a large class size in a very short period. This is however a detriment to students learning in that only one sense organ is involved in learning. The advantages of lecture method according to (Oladapo 2008) include the following:

i. It saves time and energy. It is not expensive as only the chalk is required. Good Command of language and boldness saves the teacher a lot of challenge in the class.

ii. It offers easy coverage of syllabus and faster dissemination of scientific information and facts.

iii. It allows easy handling of large classes without much stress. The students are given the same marital content at the same time, that is, there is uniformity in the facts the students are given.

iv. The student's efforts in searching for facts in books are saved as they are told the facts by the teachers.

The teacher has the full control of what the students should learn or know.

Disadvantages

The disadvantages as pointed out by Blair and Simon (1998) are as follows:

Meaningful learning of science is never promoted as it appeals to only sense of hearing.

The different ability groups present in any given class are not taking care of those students who will learn better by handling and manipulating of objects are completely left out. This can be frustrating for this group of students.

It is stressful for students to sit for a long time at once listening and writing. It can lead to restlessness and disruption of normal class procedures.

Traditional method encourages only role learning without necessary aiding understanding.

The students are passive and spoon- fed. It is teacher – centered.

2.10 Concept of Performance

Performance assessment is the direct, systematic observation of an actual student's performance and rating of that performance according to the pre-established performance criteria (Angyaye, 2007). Students, when asked to perform a complex task

or create a product, they are assessed on both the product and the end result of their work. Many performance assessments include real life task that calls for higher order thinking (Angyaye 2007). The performance based approach to education enables students to use their knowledge and apply skills in realistic situations. It differs from the traditional approach to education in that it strives for mastery of knowledge and skills; it also measures these in the context of practical task. Furthermore performance- based education focuses on the process students go throughout the learning process (Onocha 1985). In addition, performance- based education stimulates the development of other important dimension of learning namely the affective, social and meta-cognitive aspect of learning (Onocha 1985).

Performance- based education motivates students to participate in interesting and meaningful tasks. It helps students develop a sense of pride in their work, fostering confidence in the target language. The assessment thus enables students to demonstrate specific skills and competence by performing or producing something. Through performance- based teaching, teachers can track pupils, work on a task, show them the value of their work processes and help monitor them to use tools as periodic reflections working files and learning logs more effectively (Adesokan, 2002). The following are some of the advantages of performance assessment on students by (Adesokan, 2002):

i. It encourages problem solving and critical thinking skills
ii. It encourages divergent thinking
iii. It focuses on both product and process
iv. It promotes independent learning involving planning, revising and summation
v. It builds on pupils' prior experience

vi. It can include opportunities for peer interaction and collaborative learning

vii. It enables self-assessment and reflection

viii. It is interesting, challenging meaningful and authentic

ix. It requires time to complete.

An extended performance task may develop into a project; following definition of project adapted from Wiggin's (1999). A project is an extended and complex performance task, usually occurring over a period of time. Projects usually involve extensive student's enquiry cumulating student's product performance which is asserted using a variety of assessment tools.

Performance based teaching and assessment requires teachers to determine the knowledge the pupil needs to acquire and how it can be applied at the beginning of the planning process (Raimi 2002). A major difference between implementing performance based assessment and traditional testing is that in a performance based approach, assessment occurs throughout the teaching/learning process. The teacher unit's plans must illustrate how each of the teaching goals is assed in the unit. With the curriculum, teachers select the principal bench mark in the various domains and the pre-requisite knowledge and skills required to perform this bench marks. At this stage, the appropriate assessment method needs to be matched to each goal and should measure pupil performance (Raimi 2002).

2.11 Academic Performance in Chemistry

Academic performance is defined as the measure of what a person has accomplished after exposure to educational programmes. In research conducted by Harry (1990) on the effect of inquiry method and the essential benefits of inquiry approach, he shows that students exposed to inquiry instructional method scoredhigher

than those students who were taught the same concept using subject matter approach. Shymansky, *et al,* (1983) presented a meta-analysis of the effect of inquiry associated curricular on the students' performance and found that the curricular enhancedstudents' science achievement through inquiry.

Recent science education standards in U.S. proposed that all students should learn about both scientific inquiry and learn science through inquiry (National Research Council 1986). However, some previous researches have shown that an inquiry-based instruction method can improve students' science-process skills concept learning and achievement in chemistry. Research on explicit teaching, (traditional instruction) has also revealed that students' achievement is improved for certain kinds of instructional objectives (Waxman, 1991).

2.11.1 Students Attitudes and Performance in Chemistry

Students' performance in chemistry depends on many factors and stands out to show how well a student is doing. Festus (2007), contend that performance appears generally to be the fundamental goal behind every life struggle, but the positive platform has consequential effects of improving the worth of the students and can only be achieved through acquisition of positive learning attitudes. The attitudes of a student trigger his behavior. Attitudes are antecedents which serve as inputs or stimuli that trigger actions.

Attitude is an emotional state of individual towards an object or situation. Blair and Simon (1998), see attitude as a propensity of an individual to respond in a certain way to a stimulus. Flowers (1987), defines attitude as a particular feeling about an object or thing and therefore involves a tendency to behave positively or negatively in situations that involves a tendency to behave positively or negatively in situations that

involve the object or thing. From the above definition, it reveals that an attitude is directed toward object and this may be an individual, school policy subject or even ideas or any material object. Wilson and Soyibo (1985), in their studies reported that students' positive attitudes to science correlate highly with their science achievement. In order to solve chemistry problems in an acceptable manner, the problem solver must have both conceptual scientific and procedural knowledge (Ekpete, 2002).Bichi (2002), have reported that male and female students generally have no differences in their performances if they are exposed to problem solving strategy. With Particular reference to integrated science, Wilson &Soyibo (1985), found no significant gender differences in Jamaican 11^{th} graders' performance in integrated science. However, many studies showed that students frequently do not use conceptual understanding in solving chemistry problems. These studies also provided evidence that students were limited in their ability to solve distant transfer problems without an in-depth understanding of relevant chemistry concepts. Nakhleh (1993), opined that chemical educators and teachers have often assumed that success in solving chemistry problems should indicate mastery of the chemistry concepts. According to Greenwald (2002), the best way for students to learn chemistry is to experience challenging problems and the thoughts and actions associated with solving them. Song-Ling and Chumyen (1998), revealed that the inquiry-oriented instruction method produced significantly more positive attitudes towards the subject matter among science students that did the traditional lecture method. They further stated that the inquiry teaching method significantly promotes positive attitudes towards science among group participation. Rosini (1997), also examines the relation between teaching method and attitude of students and found that inquiry method is more motivating than traditional lecture method.

2.12 Attitudes of Students towards Chemistry and Instructional Method

Sola and Ojo (2007), defined attitude as beliefs and opinions that can predispose individual to behave in certain ways. Attitude can be seen as to comprise of cognitive and effective component, attitudes are thought to influence future behaviors and have implications for such things as learning, Kay (1990), when he reported that both cognitive and affective attitudes were significant predictors of commitment to the use of learning. Song-Ling and Chun-yen (1998) revealed that the inquiry-oriented instruction method produced significantly more positive attitudes towards the subject matter among science students than did the traditional lecture method. They further stated that the inquiry teaching method significantly promote positive attitudes towards science among group participation. Rosini (1997), also examine the relation between teaching method and attitude of students and found that inquiry method is more motivating than traditional lecture method. German (1989), examined the effects of inquiry teaching method on geology achievement and students attitudes towards science. He indicated that inquiry teaching method improved academic achievement and enhanced the students' attitude towards science.

2.13 Factors Affecting Students' Performance in Chemistry

Despite the prime position chemistry occupies in our educational system and effort made by researchers to enhance performance, students' chemistry performance in general is still low (Baja, 1976). Some of the reasons identified for this failure are laboratory inadequacy, teacher's attitude, examination malpractice, non-professionalism and environment. Science practical in schools is aimed at giving the students the opportunity to gain meaningful learning, acquire appropriate skills and attitude that enables them live and contribute to the development of the society (Lawrence and Abraham, 2011).

In view of the above factors suspected to be some of the reasons why students' performance in chemistry continue to decline,a study conducted by Lawrence and Abraham (2011), investigated the low achievement in chemistry within some selected schools in Zaria Local Government ranging from teachers variables (attitude, qualification, attendance at chemistry workshop, condition of service), student variable (class of career, attitude) and environmental related variable (class size, school location and laboratory adequacy) showed that most teachers in the teaching professions are not thereby choice, rather by accident, they consider it to be a waiting ground for better jobs. Such teachers have no passion in teaching. Under student's attitude towards chemistry, most students consider it to be a difficult subject,and therefore, the passion for learning continues to decline. Under teacher variable, non-professionalism is also a major problem as some teachers are teaching chemistry but are not graduates of chemistry. Also under environmental variables, in some schools where students' population is large, the classes are divided into sets. (For example, Set1, set2 …and so on)with two contacts of 40minutes every week while in other schools it is four contact of 40minutes for other days and 35minutes every Fridays. When asked if it is possible for them to cover their syllabus before the students face their external examination, most had to say it's not possible. Other factors affecting student's performance in chemistry include:

Class size:Some teachers were asked to what extent the size of their classes affect their teaching. Most teach a large class with many students and some others despite the fact that a class is large tend to teach three classes.

Condition for service/remuneration: Poor remuneration and poor staff welfare has destroyed the morals of most teachers. Most of them are salary conscious and tend to look down on the payment for service.

Laboratory adequacy: Chemistry is a subject that involves a lot of demonstration and can only be effectively taught for easy access to instrumental materials, however most schools lack essential qualities/facilities. Most of the schools do not have a laboratoryor even ifthey have, most of them are not well equipped.

Examination malpractice: one of the teachers noted that most of the students choose to relax because of what will come out of their teachers and parents. Some of the teachers observed that examination malpractice affect the students to a very great extent, the student, teachers, parents and invigilators are all involved.

Choice of career: Some students are not into sciences by their own personal choice, some are into it because of their parents, and guidance, and so on who insist they must be science students.

From the factors mentioned above, it can be understood that the teachingprofession has been reduced to transit job. People donot have passion for teaching and such attitude reflects in the way they teach this subjectwhich has adverse effects on student's performance. It is also evident that students negative attitude towards chemistry is what is often to the low performance that is experienced today (Ojo, 1989). Time constraints is one of the major factorsresponsible for poor performance and is also one of the reasons why syllabus is not covered as science practical's are not conducted (Adesokan, 2002). The work of Lawrence and Abraham (2011) also suggests that students would have performed better if exposed to a chemistry practical lessons in good time, student tend to also understand and recall what they see more than what they hear as a result of using laboratories in the teaching of science. On the effects of examination malpractice, it was reported that it has done so much harm than good to student performance not only in chemistry but also in general science subject. It is obvious that students who did not learn cannot perform and

sinceexamination is still the common index for measuring performance especially in our society, passing has become a do or die affair such that a teacher who did not do his work well probably because of lack of time but want to please the school and the parents, indulge in examination malpractice and the students end up coming out colorful but with no knowledge of the subject (Lawrence and Abraham, 2011). The students are aware that even if they are not serious and well taught, they will still be made to pass at the end by their parents or teachers.

2.14 Reasoning and thinking Condition for Better Performance in Chemistry

Reasoning and thinking condition is a type of reasonable and reflective thinking that is aimed at decidingwhat to believe or what to do. It is a way of deciding whether a claim is always true, sometimes true, partly true or false (Ennis, 1987). Critical thinking can be traced in western thought to the sarcastic method of ancient Greece and in the east to the Buddhist Kalama sutra. Critical thinking is an important component of most professions including chemistry. It is part of formal education process through graduate's education (Brookfield, 2000).

The list of core critical thinking in chemistry includes observation, interpretation, analysis, interference, evaluation, explanation and cognition.There is a reasonable level of consensus among experts that an individual or group engaged in strong critical thinking gives due consideration to establish:

i. Evidence through observation

ii. Context

iii. Relevant criteria for making the right judgment

iv. Applicable methods or techniques for forming the judgment

v. Applicable theoretical construct for understanding the problem and the question at hand.

To process strong critical thinking skills one must be disposed to engage problems and decisions using those skills. Critical thinking employs not only logic but broad intellectual criteria such as clarity, credibility, accuracy, precautions, relevance, depth, breath, significance and fairness (Edwin, 1941).

2.13 Empirical Studies

A study was carried out inOgun state by Bimbola(2010), on the effects of constructivist-based teaching strategy on academic performance of students in integrated science at junior secondary school level. A Quasi-experimental research design was used to conduct the research. The study involved 120 junior secondary schoolstudents in Ijebu-Ode Local Government Area of Ogun State, South-West Nigeria. Findings revealed that the constructivist instructed students had higher scores on the post test, compared to those exposed to conventional (lecture) method of teaching. It also puts that in a constructivist setting, knowledge is not objective, mathematic and sciences are viewed as systems with modelsthat describe how the world might be rather than how it is. These models derive their validity not from their accuracy of any predictions which might be based on them (Postle, 1993). The research study recommends that if integrated science teachers could incorporate constructivist-based teaching strategy into their teaching methods, there would be an improvement in academic performance of junior secondary school students in integrated science. It also recommends that students should be allowed to apply what they learn in school to the various and unpredictable situations they encounter in the course of their study. The reviewed work is closely related to the present study in the sense that both studies focused on “the effect of teaching method on students’ performance” however

thedifference between the two studies is that the former is about the performance of students in integrated science at the junior secondary school level while the latter is on the performance of students in chemistry at senior secondary school level.

A study was carried out by Hamid &Azita, (2009) on “the effect of educational factors on the Academic Performance of University Students in Chemistry”. The population of the research involved all the university students of ShaidBahonarUniversity of Keman who had chosen the course “general chemistry 1”. A questionnaire was used for obtaining necessary data from thepopulation sample. The result of the research showed that motivation, previous experience, emotional conditions, instructors, evaluation procedures, academic records and age as educational factors had positive effect on the university student’s academic performance. Furthermore, the study revealed that the educational performance of those university students who have a high motivation is better than those students who have a low motivation. Also the education performance of those students whose emotional learning environment was desirable has been higher than those students whose emotional learning environment was undesirable.

The study recommends that, professionals of chemistry should increase the amount of motivation of the students towards chemistry, pay attention to the student’s previous experiences on chemistry and create a very good and suitable emotional conditions and situation for students.The reviewed work of Hamid and Azita, (2009) closely related to the present study such that both studies discussed the academicachievement/performance of students in chemistry but Hamid &Azita’s study is on Effects of Educational factor on the academic performance of university students in chemistry while the present study is on the Effects of Inquiry Teaching Method on Students’ Performance in Chemistry

Agboola and Oloyede (2007) carried out a study on the Effects of project, inquiry and lecture-Demonstration teaching methods on senior secondary Students' Achievement in Separation of Mixtures practical test. The objective of the study was to assess and compare the relative effectiveness of three methods for teaching and conducting experiments in separation of mixture in chemistry. A quasi-experimental pre-test post-test control group design was used to conduct the research. The research instruments used for pre-test, post-test was tagged Chemistry Achievement Test (CAT) 1 and 2. A total of two hundred and thirty three senior secondary school one (SSS1) science students constituted the subjects for the study. The data was analyzed using t-test analysis, one way analysis of variance (ANOVA) and Scheffepost-hoc analysis. The analysis and results of the study showed that the project method brings about a significant difference in the achievement of the experiments of subjects in the experimental group compared with those exposed to inquiry and lecture-demonstration methods of teaching Separation of Mixtures as a Model of Experimental Aspect of Chemistry. The research work is related to the present study in terms of methodology and research instrument used but differ in terms of geographical scope and objectives.

Mao and Chang (1997) carried out their study on "The impacts of an Inquiry Teaching Method on Earth Science Students' Learning Outcomes and Attitudes at the Secondary School Level". The objectives of the study were to investigate the impacts of an Inquiry Teaching Method on Ninth Grade Earth Science Students' Achievement and Attitude Toward Earth Science in Secondary Schools. The design used for the study was quasi-experimental non- equivalent control group design. The populations comprise 557 Ninth Grade Earth Science Students drawn from four junior high schools in 14 classes. Instruments used were earth science achievement test and attitude toward earth science inventory. Analysis of covariance (ANCOVA) and inferential statistical analyses were carried out using SPSS (statistical package for social sciences version 7.0). Analysis

of covariance revealed that the inquiry–oriented instructional method produced significantly greater achievement among ninth grade earth science students than the conventional teaching approach and students in the experimental group developed more positive attitude toward earth science than did those in the control group. The work is related to the present study in such a way that both of them are on effects of inquiry method on students' performance, however, it differ in subject and educational level.

Sevilay (2004) carried out a study on the effect of inquiry based chemistry course on students' understanding of atom concept, learning approaches, motivation, self-efficacy, and epistemological beliefs. The purpose of the study was to explore the effects of inquiry-based high school chemistry course and gender differences with respect to students' understanding of atom concept, learning approaches, motivational goals, self-efficacy, and epistemological beliefs. Non-equivalent control group design was used to conduct the research. The research instruments used for the research were tagged Chemistry Achievement Test (CAT), Learning Approach Questionnaire, Achievement Motivation Questionnaire and Science knowledge Questionnaire instrument .A total of 47 ninth grade chemistry students were used as sample for the study. T-test and ANOVA were used to analyze the data. Research findings revealed that the students who used the inquiry oriented instruction had significant higher scores with respect to achievement related to atom concept than the students who were taught with the traditionally designed chemistry instruction. The research work is related to the present study in terms of the instructional strategy used (Inquiry and Traditional method) and design used but the differenceis that, the study by Sevilay is on 'Effects of Inquiry Based on students' understanding of atom concept,learning approaches, motivation, self-efficacy, and epistemological beliefs' while the present study is on the Effects of Inquiry method on students' Performance in Chemistry.

A study was also carried out by Wilson, Taylor, Kowalski and Carlson (2009), on The Relative Effects and Equity of Inquiry-Based and Commonplace Science Teaching on Students' Knowledge, Reasoning, and Argumentation. The objective of the study was to investigate whether causal inference could be made about the effectiveness of inquiry-based instruction. A laboratory-based randomized control design was used. A sample of 58 students were randomly selected and used for the study. The research instrument comprised a survey and a standardized open-ended interview that contained four multiple choice items, eight true/false item and five constructed response items. Data was analyzed using interclass correlation. This study found that students receiving inquiry-based instruction reached significantly higher levels of achievement than students experiencing commonplace instruction and also, the mean scores for the inquiry-based unit were significantly higher than the mean scores for the commonplace. This study is similar to the present study in terms of one of its objectives (investigating the effectiveness of inquiry method as an instructional strategy)however, it differs in terms of the instruments used, procedures for data collection and the methods for analyzing data.

Ozdileke and Bulunuz (2009), carried out a research work on "the Effect of a Guided Inquiry Method on Pre-service Teachers' Science Teaching Self-Efficiency Beliefs. The aim of the study was to examine the effectiveness of guided inquiry method for science teaching on elementary pre-service teachers' self-efficiency beliefs. A pretest/posttest one group research design was used. The Elementary Science Teaching Efficiency Belief Instrument (STEBI) was completed by the participants. Focus group interview were conducted with 10 groups of participants. The study's sample consisted of one hundred and one (101) second year pre-service elementary teachers. The data were analyzed by using paired sample t-test with Spss 16.00 program at the 0.01 significance level. Qualitative and quantitative findings indicated that levels of

participants' efficiency expectations and outcome expectations on posttest scores were higher than the pretest scores. Also, the effectiveness of a guided inquiry method to increase the sense of self-efficacy beliefs of pre-service teachers in science teaching was presented. Therefore, the similarities between Ozdileke and Bulunuz's work with the present research work is that both made use of the same research design however both study differ in instrument used and target population.

A study was carried out by Hussaini, Azeem and shakoor (2011) on Physics Teaching Methods; Scientific inquiry Vs. Traditional Lecture. The major objective of this study was "to study the effect of three levels of scientific inquiry method and traditional method of teaching physics on students' performance and their proficiency to apply the physics knowledge in real life situations. The pretest posttest control group experimental design was used in this research study. Three instruments were used in the study which are; physics proficiency test, students' intelligence test and socio-economic status Performa. 175 male physics students of 10^{th}grade were selected and used as sample for the research study. Data were analyzed by using Content alignment analysis. The research work explored that there is significant effect of guided, unguided and combination scientific inquiry on students' achievement than traditional physics teaching method and their proficiency to apply the concepts of physics in real situations. The revived work is similar to the present study in such that both examined two teaching methods (inquiry Vs. traditional method) on students' achievement but the difference is that the former was performance in physics while the latter is performance in chemistry.

Saeed,(2011), carried out a study on The Effect of Inquiry Method on Achievement of Students in Chemistry at Secondary Level. The major objectives of the study were: to find out the relative effects of inquiry based instruction as supplementing strategy on the academic achievement in chemistry and low intelligence. The study

made use of an experimental research design alongside with a Chemistry Achievement Test (CAT) as instruments for the study. 45 senior secondary 111(SS3) students were selected as sample for the study. Obtained data were analyzed by applying t-test. Findings showed the supremacy of inquiry approach. The study is similar to the present study in terms of the instrument used (Chemistry Achievement Test) as well as the teaching method (inquiry method on students' performance in chemistry) but the difference lies in its objectives.

A research study by Pandey, Nanda and Ranjan, (2011), on the Effectiveness of Inquiry Training Model over Conventional Teaching Method on Academic Achievement of Science Students in India revealed the following; the objective of the study was to investigate the effectiveness of inquiry training model over conventional teaching method in teaching physical science at secondary level of science students. The research design used was a randomized group pre-test post-test design in true experimental design. The research made use of an Achievement test in physical science (ATPS). A total of 100 students participated in the study. Results revealed a statistically significant Effects of Inquiry Training Model (ITM) over Conventional Teaching Method on Academic Achievement of students and also, that, the teaching of physical science through the inquiry training model is more effective than the teaching through the conventional method at the senior secondary level.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This study investigated the effects of guided inquiry method on students' performance in chemistry in senior secondary schools in Kaduna state, Nigeria. This chapter examines the methodology employed in carrying out the study. The chapter focuses on research design, population of the study, sample and sampling procedure, instrumentation, validation of instrument, reliability of instrument, method of data collection and method of data analysis.

3.2 Research Design

Design for this study is quasi-experimental pre-test and post-test experimental and control group. The purpose of using this design agrees with Kolo (2003), who says that "experimental is to investigate possible cause and effect as well as relationship between two or more variables by the application of treatment which cannot be resolved by observation or description". Theexperimental and control groups were pre-tested to determine the group equivalence at the start of the experiment.

3.3 Population of the Study

The population of this study consisted of all chemistry students in Government Senior Secondary schools in Kaduna state. There are at present, twenty one (21) Government Senior Secondary Schools with a total number of five thousand, nine hundred and thirteen(5,913) chemistry students.

Details of the population are given in Table 3.1

Table 3.1 population of the study

SN	Name of senior secondary schools	LGA	No of chemistry students	No.of students	Total
			M	F	
1	G.S.S Zaria (Snr)	Zaria	102	-	102
2	G.G.S.S (WTC) Zaria	Zaria	-	238	238
3	G.S.S Magajiya	Zaria	137	100	237
4	Barewa College (Snr)	Zaria	340	-	340
5	G.S.S Dakachi	Zaria	112	97	209
6	G.S.S.S Kaura	Zaria	153	100	253
7	G.S.S TudunJukun	Zaria	320	410	730
8	G.G.S.S Pada (Snr)	Zaria	-	135	135
9	Al-hudahudacollege (Snr)	Zaria	257	-	257
10	G.S.S K/Kuyanbana	Zaria	260	188	448
11	G.G.S.S K/Gayan	Zaria	-	328	328
12	G.S.S KofanJatau	Zaria	157	130	287
13	G.S.S Aminu (Snr)	S/gari	302	-	302
14	G.S.S Muchiya	S/gari	111	67	178
15	G.G.S.SDogonBauchi (Snr)	S/gari	-	237	237
16	G.S.S Tudun Saibu (Snr)	Soba	160	73	233
17	G.S.S Chindit (Snr)	S/gari	320	-	320
18	G.G.S.S Chindit (Snr)	S/gari	-	259	259
19	G.S.S Dinya	Soba	96	71	167
20	G.S.S Likoro	Makarfi	200	120	320
21	G.S.S Yakasai	Soba	102	231	333
	TOTAL				5913

Source: Respective schools, Zaria inspectorate Division of Kaduna state, (2012)

3.4 Sample and Sampling Procedure

A sample of 120 senior secondary 11 (SS2) chemistry students were selected by random sampling from 2 urban and 2 rural schools which comprised both boys and girls with 30 students each in experimental and control groups respectively. The number of chemistry students in these four schools is one thousand and twelve (1012) students. The sampling technique was used because, according to Freankle and Willen (2000), it ensures that all key characteristics of individuals in the population are included in the same proportion and it increases the likelihood of the sample being a true representation of the population. Also, the sample size of (120 students) was sufficiently large enough for an experimental study of this nature as it conformed withFraenkle an Willen (2000) who reported that the recommended minimum number of subjects is 30 in each experimental and control group. In the experimental group, there were 36 males and 24 females while in the control group there were 27 males and 33 females. The number of the samples in both experimental and control groups were 60 each, the groups are located at Zaria andSabongari Local Government areas of Kaduna state, Nigeria. The distribution of the samples drawn from the population is given in the table 3.2

Table 3.2: Representssample distribution of schools and students in Zaria Inspectorate Division

S/N	Name of schools	Populationof chemistry students	Group	Sample
1	G.S.SMagajiya	237	(Urban) Experimental	30
2	G.S.S Dakachi	209	(Urban) Control	30
3	G.S.S Tudun Saibu	233	(Rural) Experimental	30
4	G.S.SYakasai	333	(Rural) Control	30
	TOTAL	1012		120

The choice of the four (4) schools above is because they share common characteristics like student's type, academic objective, educational facilities and educational policies. This is according to Nwana (1985), a simple random sampling procedure.

3.5 Instrumentation

The instrument that was used in the collection of data was a self-constructedchemistry achievement test (CAT). The instrument was used in order to have a face to face contact with the respondents so as to assess the data required in the study. The CAT had two parts; the first part seeks response on students' personal data such as name, school, sex and class while part 2 was based on question items on the concept of separation technique, acids, base and salt. It consisted of 30 multiple choice

items with four (4) options A-D which was scored 2marks each alongside with five short essay items scored 8 marks each. The CAT was marked 100%. Students who scored below 50 were considered to have scored below pass mark while those that scored 50 and above were considered to have scored above pass mark see appendix 1 for the test items.

3.5.1 Validity of the Instrument

The instrument used in this study wasself-developed by the researcher. After drafting the thirty five (35) test items for the achievement test, they were given to supervisors who made some adjustment to determine the face and content validity of the instrument with the objectives and hypotheses of the study. Necessary corrections and modifications were made which lead to the final copy.

3.5.2 Pilot study

A pilot study was conducted to establish the suitability of the instrument. Twenty ss2 chemistry students of Government Senior Secondary School MuchiyaSabonGari, Kaduna state were randomly selected for the pilot study.The purpose of the pilot study was to determine the reliability co-efficient of the instrument of the study through a trial run.

3.5.3 Reliability of the Instrument

The data collected through the pilot study were statistically analyzed for the purpose of obtaining reliability of the instruments. A reliability co-efficient of 0.89 was obtained. This reliability co-efficient was considered adequate for the internal consistencies of the instruments. This was a confirmation of test of reliability which is according to Spiegel, (1992) and Stevens (1986). According to them, an instrument is considered reliable if its reliability coefficient lies between 0 and 1, and that the closer

the calculated reliability coefficient is to zero, the less reliable is the instrument, and the closer the calculated reliability co-efficient is to 1, the more reliable is the instrument. This therefore confirms the reliability of the data collection instrument used as fit for the main work.

3.6 Administration of Treatment

It is important to distinguish between guided inquiry and traditional instructional method used in the study. According to Flowers (1987), guided inquiry based teaching is emphasizing observation and interpretation of data. Guided inquiry based instruction in this current study emphasizes hands-on, minds-on activities that involves gathering data and critically to examining the data for relationship and interpretation. The experimental group which consist of 60 chemistry students were subjected to six weeks teaching, using the guided inquiry based method to teach separation technique, acid, base and salt concepts where all materials needed was provided to students. These materials include different types of apparatus, acid (strong and weak), base, different types of salts and litmus paper. All other materials that would make a guided inquiry method of instruction a success were provided. During the lesson, the students carried out different activities and investigations under the supervision of the researcher. The most important characteristics of the lesson was that, the lesson was ‘‘student centered’’. Activities were designed to encourage students to become more adapted to using science process skills and more knowledgeable about separation technique, acid, base and salt concept.

The control groups which consist of the same number of students as in the experimental group were also subjected to six weeks teaching using the traditional method. A number of variables were held constant so that statistical comparison between experimental and control groups could be made.

3.7 Procedure for Data Collection

The procedureused for data collection was in four stages;

Stage one: An introductory letter was presented for permission to be obtained from the authorities of the schools that were involved for the use of their students and their lesson period once a week for six (6) weeks each to both experimental and control schools.

Stage two: The students (experimental and control groups) of the study were subjected to pretest under the same condition to determine the level of their performances for the purpose of comparison. The results were collected by the help of the research assistant.

Stage three: Twelve (12) weeks lesson plan for experimental group and control group was prepared. The two groups were then exposed to chemistry instruction on separation technique, acid, base and salt concepts. Experimental group was taught for a period of six (6) weeks using guided inquiry methodwhile control group was taught using traditional method for a period of six (6) weeks as well.

Stage four:A post-test was administered to both experimental and control groups in all the sampled schools at the end of their six weeks each with the same items as in the pretest. This was to determine the mean scores of the two groups. After the test, results were collected for analysis.

3.8 Method of Data Analysis

The data collected were analyzed using t-test statistic at 0.05 level of significance to answer the research questions as well as the null hypotheses. It was used to determine whether or not there is significant difference between guided inquiry

teaching method and traditional method on academic performance of chemistry students in Government Senior Secondary Schools in Kaduna state.

CHAPTER FOUR
DATAANALYSIS ANDDISCUSSION OF RESULTS

4.1 Introduction

This chapter presents the data analysis including its discussion of results. The data was gotten from selected chemistry students in selected senior secondary schools in Kaduna state, on the effects of Inquiry method on academic performance. A total of 120 students were used for this study. Sixty each was used for experimental and control groups respectively. The analysis of data collected is done using Statistical Package for the Social Sciences (SPSS) 20th Edition.The first section of this chapter presents the frequency and percentages of the personal data variables analysis which include sex, treatment group and location. The second section present the answers to research questions using comparative mean, standard deviations and standard errors. The third section presents and interprets the four null research hypotheses structured along the research objectives by means of inferential statistical technique of Independent t-test and paired sample t- test to determine presence or absence of significant differences or effects. All hypotheses are based on 0.05 alpha level of significance. The fourth section outlined the major findings of the study and the last section discussed the findings of the study in detail.

4.2 Analysis of personal data distribution.

Table 4.2.1: Group

Treatment group	Frequency	Percent
Experimental	60	50.0
Control	60	50.0
Total	120	100.0

The selected students were categorized into two groups. One school from urban and one school from rural comprising of 60 or 50 was taught using inquiry method categorized as experimental group. In the same vein, one school from urban and one school from rural comprising of 60 or 50.0% was taught using traditional teaching method categorized as Control group.

Table 4.2.2: Location of schools

Location of schools	Frequency	Percent
Urban	60	50.0
Rural	60	50.0
Total	120	100.0

The table above revealed the location of the respondents, It showed that 60 (50.0%) were students sampled from urban located schools while the rest 60 (50.0 %) were sampled from rural located schools. This implies that equal number of students was used from both urban and rural located schools

Table 4.2.3: Sex

Sex	Frequency	Percent
Male	63	52.5
Female	57	47.5
Total	120	100.0

The table above showed that male students accounted for 63 or 52.5% of the total samples while female students accounted for the rest 57 or 47.5% of the sample. This implies that males and females were ably represented in this study.

Table 4.2.4: School

Schools	Frequency	Percent
GSS Magajiyya	30	25.0
GSS Dakachi	30	25.0
GSS Tudun Saibu	30	25.0
GSS Yakasai	30	25.0
Total	120	100.0

According to the table above, 4 senior secondary schools were used for this study. The schools are GSS Magajiyya, GSS Dakachi, GSS Tudunsaibuand GSSYakassai.

Each of this school has 30 (25.0%) respondents totaling 120 students from the four selected schools.

Table 4.3:1 Research Questions

Variable	Treatment Group	N	Mean	Std.dev	Std. Err
Academic performance in Chemistry	Experimental	60	52.74	8.51	1.09
	Control	60	48.52	8.48	1.09

Research question1: What is the effect of inquiry method and traditional methodon the performance of Chemistry student's senior secondary schools?

Table 4.3.2: Descriptive statistics on the mean differences in the Chemistry academic performance of Experimental and control groups senior secondary school students of Kaduna state.The table above is a descriptive statistics on the mean academic performance of students taught with inquiry teaching method (experimental) and those taught with lecture method (control). Their mean academic performances are 52.7417 and 48.5167 respectively. This implies that students taught using inquiry teaching method had higher academic performances than those taught using lecture teaching method.

Research question 2: What is the effect of inquiry method on the performance of Chemistry students of senior secondary schools?

Table 4.2.2: Mean Academic performances in the pretest and post test academic performance of students taught with inquiry teaching method.

Performance of chemistry students of experimental Group	N	MEAN	STD.DEV	Std.err
Pre test scores	60	50.45	9.22	1.19
Post test scores	60	55.03	8.49	1.09

According to the descriptive statistics above, the mean academic performance of the students taught using inquiry teaching method was 50.45000 and 55.0333 in their pretest and post test scores respectively. This shows that their post test scores after being exposed to the inquiry teaching method is higher than their pretest scores before being exposed to the inquiry teaching method. This implies that there is positive effect of the inquiry teaching method in the chemistry academic performance of SS2 students in Kaduna state.

Research Three: What is the effect of inquiry method on the performanceof male and female students in Chemistry?

Table 4.2.3: Descriptive statistics on the mean differences in the Chemistry academic performance of Males and Females Senior Secondary school students taught using Inquiry teaching method (experimental) in Kaduna state.

Variable	Gender (experimental group)	N	Mean	Std.dev	Std. Err
Academic performance in Chemistry	Male	36	52.72	10.19	1.69
	Female	24	52.77	5.22	1.06

The table above revealed the chemistry academic performance of Male and Female Senior Secondary school students taught using Inquiry teaching method (experimental) in Kaduna state. Accordingly, their chemistry academic performances were 52.72 and 52.77 by male and female students respectively. There is little or no difference in the academic performances of students exposed to inquiry teaching method, on the basis of their gender. This implies that the treatment is good for both male and female students, as there is no difference between both genders.

Research Four: What is the difference in the performance between urban and rural studentstaught using inquiry teaching method?

Table 4.2.4: Descriptive statistics on the mean differences in the Chemistry academic performance of Urban and Rural Senior Secondary school students taught using Inquiry teaching method (experimental) in Kaduna state.

Variable	Location (experimental group)	N	Mean	Std.dev	Std. Err
Academic performanceChemistry	Urban	30	53.03	8.60	1.57
	Rural	30	52.45	8.53	1.55

The table above revealed the chemistry academic performance of Urban and Rural Senior Secondary school students taught using Inquiry teaching method (experimental) in Kaduna State. Accordingly, their chemistry academic performances were 53.03 and 52.45 by Urban and Rural students respectively. There is little or no difference in the academic Performances of students exposed to inquiry teaching method, on the basis of their locations. This implies that the treatment is good for both Urban and rural students, asthere are no difference between both locations.

4.4 **Testing Research Hypotheses:**

Hypothesis 1: This null hypothesis state that there is no significant difference in the academic performance between senior secondary school students taught using Inquiry teaching method (experimental) and those taught using traditional lecture method (control) in Kaduna state.

Table 4.4.1 Independent t-test sample statistics in the Chemistry academic performance of Experimental and control groups' senior secondary school students of Kaduna state.

Variable	Treatment Group	N	Mean	Std.dev.	Std. Err	Df	t calculated	t-critical	Sig (p)
Academic performance inChemistry	Experimental	60	52.74	8.50	1.09	118	2.72	1.96	0.00
	Control	60	48.51	8.47	1.09				

Calculated t > 1.96, calculated p < 0.05

Results of the independent t-test statistics showed that significant difference exist in the academic performance between senior secondary school students taught using Inquiry teaching method (experimental) and those taught using traditional lecture method (control) in Kaduna state. This is due to the fact that the calculated p value of 0.007 is lower than the 0.05 alpha level of significance while the t-calculated value of 2.72 is higher than the t-critical value of 1.96,

at df 118. Their calculated mean academic performance in chemistry were 52.74 and 48.51 by experimental and control groups students respectively. Consequently the null hypothesis which states that there is no significant difference in the chemistry academic performance between senior secondary school students taught using Inquiry teaching method (experimental) and those taught using traditional lecture method (control) in Kaduna state, is hereby rejected.

Hypothesis 2:This null hypothesis states that there is no significant effect of Inquiry teaching method on the academic performances of chemistry students in senior secondary school in Kaduna state.

To test this hypotheses the pretest and the post test of the 60 experimental group of Chemistry SS students were computed to determine if significant effect exist as a result of exposure to the Inquiry treatment, hence the use of paired sample t-test statistics between their pretest and post test scores.

Table 4.4.2: Paired Sample t-test statistics on the effects of Inquiry teaching method on the academic performance using pre test and post test scores of students taught using Inquiry teaching method (Experimental) of Kaduna state.

Performance of chemistry students of experimental Group	**N**	**Mean**	**Std.Dev**	**Std.err**	**Df**	**T calculated**	**T critical**	**P (sig)**
Pre test scores	60	50.45	9.21	1.18				
Post test scores	60				59	7.14	1.96	0.00
		55.03	8.49	1.09				

P calculated< 0.05 t calculated > 1.96 at df 59

According to the paired sample statistics above, significant effects of Inquiry teaching method exist on Academic performance of Senior Secondary School Chemistry students in Kaduna state. This is due to the fact that the calculated p value of 0.000 is less than the 0.05 alpha level of significance and the calculated t value of 7.140 is higher than the t critical value of 1.96 at df 59. Their mean scores were 50.4500 and 55.0333 for pre test and post test respectively in their Academic performance of experimental Group, showing that they had increased academic performance in chemistry after being exposed to the treatment of Inquiry among the experimental Group. This implies that significant effect exist withguided Inquiry teaching treatment on Academic performance of experimental students. Therefore the null hypothesiswhich states that there is no significant effect of Inquiry teaching method on Academic performance ofSSS chemistry students in Experimental group Kaduna state is hereby rejected.

Hypothesis 3 : This null hypothesis state that there is no significant difference in the academic performance between Male and female senior secondary school students taught using Inquiry teaching method (experimental) in Kaduna state.

Table 4.3.3 Independent t-test sample statistics in the Chemistry academic performance of male and female Chemistry senior secondary school students taught Inquiry teaching method (experimental) in Kaduna state.

Variable	**Gender (experimental group)**	**N**	**Mean**	**Std.dev**	**Std. Err**	**Df**	**t calculated**	**t-critical**	**Sig (p)**
Academic	Male	36	52.72	10.19	1.69				

performance in Chemistry	Female	24	52.78	5.23	1.06	58	0.02	1.96	0..98

Calculated t<1.96, calculated p > 0.05

Outcome of the independent t-test statistics showed that there is no significant difference in the academic performance between Male and female senior secondary school students taught using Inquiry teaching method (experimental) in Kaduna state. This is due to the fact that the calculated p value of 0.983 is higher than the 0.05 alpha level of significance while the t-calculated value of 0.021 is lower than the t-critical value of 1.96, at df 58. Their calculated mean academic performance in chemistry were 52.72 and 52.77by Male and female students respectively. Consequently the null hypothesis which sate that there is no significant difference in the chemistry academic performance between male and female senior secondary school students taught using Inquiry teaching method (experimental) in Kaduna state, is hereby accepted and retained.

Hypothesis 4 : This null hypothesis state that there is no significant difference in the academic performance between Urban and Rural senior secondary school students taught using Inquiry teaching method (experimental) in Kaduna state.

Variable	**Location (experimental group)**	**N**	**Mean**	**Std.dev**	**Std. Err**	**Df**	**t calculated**	**t-critical**	**Sig (p)**

Academic performance in Chemistry	urban	30	53.03	8.609	1.57				
	Rural					58	0.26	1.96	0..79
		30	52.55	8.54	1.56				

Table 4.4.4 Independent t-test sample statistics in the Chemistry academic performance of Urban and Rural Chemistry senior secondary school students taught using Inquiry teaching method (experimental) in Kaduna state.

Calculated t<1.96, calculated p > 0.05

Outcome of the independent t-test statistics showed that there is no significant difference in the academic performance between Urban and Rural Senior secondary school students taught using Inquiry teaching method (experimental) in Kaduna state. This is due to the fact that the calculated p value of 0.79 is higher than the 0.05 alpha level of significance while the t-calculated value of 0.26 is lower than the t-critical value of 1.96, at df 58. Their calculated mean academic performances in chemistry were 53.03 and 52.4500 by Urban and Rural students respectively. Consequently the null hypothesis which sate that there is no significant difference in the chemistry academic performance between Urban and Rural Senior secondary school students taught using Inquiry teaching method (experimental) in Kaduna state, is hereby accepted and retained.

4.5 Summary of major findings

The following are the major findings of the study:

1. The SS2 chemistry students taught using inquiry teaching method performed significantly better than their counterparts taught usinglecture teaching method.

2. There is significant effect of Inquiry teaching method on the chemistry academic performances of SS2 students in Kaduna state.

3. There is no significant difference between male and female SS2 students in their Chemistry academic performances implying that both gender benefit from the inquiry teaching method.

4. There is no significant difference between Urban and rural SS2 students in their Chemistry academic performances implying that both locations benefit from the inquiry teaching method.

4.6 Discussions of findings

Research question one seeks to find out the effects of inquiry method and traditional method on the performance of chemistry students in senior secondary schools in Kaduna State. It was discovered that students taught usinginquiry teaching method had significantly higher academic performance than their counterparts taught using lecture teaching method. This result is not entirely surprising, as in fact, confirms the assumption that students taught using Inquiry teaching method (experimental) performed significantly better than those taught using the traditional lecture method. This was confirmed by their calculated mean academic performance in chemistry which was 52.74 and 48.52 by experimental and control groupstudents respectively.In chemistry which is a core science subject demands critical thinking. This outcome agreed with Muhammad, (2007) that inquiry teaching method has been described as problem solving, critical thinking, reflective inquiry,deductive thinking and not mere personal

assumptions.It is a method of teaching that involves probing, finding out, investigating, analyzing, synthesizing, discovering, evaluating, questioning and thinking.

Research question two seeks to find out the effect of inquiry method on the academic performance of students taught chemistry. The students in the experimental group had two sessions of assessment scores. The first assessment was done in order to assess the students in his or her original understanding of chemistry as a subject especially in the area of acid, base and salt mixture recorded as their pretest scores. The students were then taken through the inquiry teaching method for six weeks by the researcher. They were again assessed using the same questions and their scores were recorded as post test. It was discovered as assumed that their post test scores was significantly higher than their pretest scores emphasizing the positive effect the inquiry teaching method has on their academic performance.This outcome supports the reviewed work of Wilson, Taylor, Kowalski and Carlson (2009) on the relative effects and equity of inquiry-based and common place science teaching on students' knowledge, reasoning and argumentation. The study found that students receiving inquiry-based instruction reached significantly higher levels of achievement than students experiencing common place instruction.

Research question three was designed to find out the effect of inquiry method on the performance of male and female students in chemistry. From the findings, it was discovered that irrespective of the sex, status of the student, inquiry teaching method has positive effects in their chemistry academic performance. This discovery therefore showed that both male and female students when exposed to the treatment of inquiry teaching method perform well in their academic mean scores implying that both male and female derive almost equal benefit from being taught using the inquiry teaching method. This was corroborated by their calculated mean academic performance in

chemistry were 52.72 and 52.77 by Male and female students respectively when exposed to the inquiry teaching method This implies that the treatment of inquiry teaching method is good for both boys and girls. This outcome agrees with Abu (2000), who reported that there was no significant difference in the performance of male and female students taught using individualized guided discovery method of teaching. This revealed that inquiry method is gender friendly. Ogu(2010), observed no significant difference between student performance scores according to their gender when they were taught using theprocessed skill-based science teaching method. Odubunmi and Onafowokan(2003), observed no difference in performance based on gender when the subjects were taught using Hands-on experience method of teaching basic science at junior secondary school level. Bichi (2002), revealed that there was no significant difference in the performance of both male and female students in the study on Effects of problem solving strategy and enriching curriculum on senior secondary school students achievement in evolution concepts using problem solving instructional method.

Research question four seeks to find out the differences in the performance between urban and rural students taught using inquiry teaching method.The students' school location does not affect their academic performance just as sex does not affect their academic performance. As long as both rural and urban school students are exposed to the same inquiry teaching method, their academic performance is almost the same. This discovery is very important to chemistry teachers to know that the application of the inquiry teaching method and not their school locations as some people erroneously believe that schools in urban location produce better results in a given teaching method. In agreement with this outcome was Hamid &Azita (2009), who carried out a research work on the effects of educational factors on academic performance of university students in chemistry. The result of the research showed that motivation, previous experience, emotional conditions, instructors, evaluation

procedures, academic records and age as educational factor had positive effects on the university students' academic performance. Also the performance of those students whose emotional learning environment was desirable has been higher than thosestudents whose emotional learning environment was undesirable. This simply implies that irrespective of school location,that is, whether urban or rural, when students are motivated with appropriate method such as inquiry, it will have a positive effect on their academic performance.

CHAPTER FIVE
SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

In this chapter, the summary of the findings from the study were presented. The conclusion and recommendations were discussed. Suggestions for further study and contribution to knowledge were also highlighted.

5.2 Summary

This study was conducted to find out the effects of inquiry method and Traditional method on the academic performance of students in chemistry in senior secondary schools in Kaduna. All science students in senior secondary school study chemistry because it is one of the core subjects in the field of science that enables students to attain their objectives. For example, students wishing to study medicine cannot do so unless they have credit in chemistry. Teachers are expected to use inquiry teaching method while teaching chemistry to enhance learning, thereby, preventing high rate of failure among students. One obvious way to improve the learning of chemistry in senior secondary schools is by making the students to be actively involved in doing and learning of the subject. “Minds-on hands on” activities are a way of improving the teaching and learning of chemistry to solve the problem of poor performance in it. Four (4) research questions and hypotheses were raised. The research was based on John Dewey theory of constructivism while the interactive review reflected the variables in the research topic which includes the meaning of inquiry teaching method; overview of traditional method and review of empirical study. The research design was the quasi experimental involving pre-test and post test nonequivalent group while the sample of students used for the study were 120 out of a population of 5913. The instrument of the research was a 30 items adapted test of multiple choices in chemistry and 5 essay questions. The four (4) hypotheses were tested using t-test statistic. Major findings of the study revealed that students taught using inquiry teaching method performed better than those taught using Traditional method. It can therefore be inferred that if Traditional method is sandwiched with Inquiry teaching method, effective learning will take place. So it can be said that, Traditional method should not be discouraged totally but should be sandwiched with other methods of teaching. More so, it was discovered in this study that Inquiry teaching method is gender friendly.

5.3 Conclusion

Based on the overall findings of the study, the following conclusions can be drawn:

The inquiry method of teaching is effective for both male and female students as both sex taught the method had enhanced academic performance in chemistry.Irrespective of school location, the inquiry teaching method is very effective for the academic performance of rural and urban schools. It has been discovered that the inquiry teaching method produces students with significantly higher academic performance than those students that are taught usingtraditional teaching method.

5.4 Recommendations

The following recommendations are hereby put forward that,

1. Teachers should be encouraged to teach chemistry SS students using Inquiry teaching method and discourage the use of lecture teaching method alone as the former technique enhance better academic performances, therefore it is highly recommended that the use of inquiry teaching method should be encouraged in all secondary schools that offer chemistry to its students in Kaduna state and other states in Nigeria.

2. The Inquiry teaching method should be applied to both male and female in urban and rural schools,

3. Government should sponsor teachers to attend workshops and seminars on the appropriate and effective use of the Inquiry teaching method in the realization of chemistry better performance among senior secondary school students Kaduna state.

4. The Ministry of Education should provide all the needed instructional and infrastructural facilities for the effective application of inquiry teaching method in Chemistry in the senior classes in Kaduna state.

5.5 Contributions to Knowledge

The study contributes to knowledge in the following areas:

1. Inquiry teaching method sandwiched with Traditional method can solve many learning difficulties especially in chemistry in Kaduna state.
2. Inquiry method encourages students' motivation to learn and improve in their academic achievement regarding chemistry as this research discovered.

5.6 Suggestions for further research

The following are suggestions for further studies in related field:

1. Effects of study attitude, interest and Inquiry teaching method on the academic performance in Chemistry of senior secondary students in Kaduna state.

2. Relationship between study ability levels and academic performance in chemistry among senior secondary school students in North Western states in Nigeria.

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APPENDIX 1

Chemistry Achievement Test (CAT) based on the concepts of separation of mixture, Acid, Base and Salt.

Instruction: There are two sections in this test (section 1 and section 11)

Section 1 contains multiple choice questions and section 11 contains short answer questions.

Below are questions on separation of mixtures: fill the data (Name, School, Class and Age etc.) and answer the questions that follow.

Personal Data

Name of school: _____

Name of student: _____

Class: _____

Sex: _____

Section 1: Answer all the questions in this section by circling the correct option

1. Which of the following is not a separating technique?

   a. Radiation b. decantation c. distillation d. chromatography

2. According to the Arrhenius theory, an acid is any substance which:

   a. React with water to form salt

   b. React with salt to form base

   c .Dissociates in water to produce hydrogen ions H+1

   d. Dissociates in water to produce hydroxyl in OH

3. Strong Acid

a. React fast

b. Dissociate completely

c. Dissociate partially

d. Has no water in it

4. According to Bransted-Lowry concept, NH3

a. Is an acid b. Is a base c. Is a salt d. None of the above

5. Mixture of water and mud can be separated by:

a. Chromatography b. filtration c. hand picking d. distillation

6. The different method colures of the green substance in leaves can be separated by:

a. Filtration b. fractional distillation c. ascending paper chromatography d. gas chromatography

7. The mixture of sulphur and iron fillings can be separated by:

a. Decantation b. distillation c. evaporation d. magnetization

8. A mixture of oil and water can be separated by:

a, Sublimation b. evaporation to dryness c. using a separating funnels d. fractional crystallization

9. The following are examples of mixtures except:

a. Suspension b. solution c. air d. oxygen

10. Distillation method is used in making _____

a. Salt b. sugar c. gin and distilled water d. substances

11. An example of substance that undergo sublimation is _____

a. Iodine b. water c. Nacl d. NH_3

12. A mixture of iron dust and zinc dust can be separated by:

a. Sieving b. magnetization c. filtration d. sublimation

13. Which of the following statements is correct about Lewis concept of acids and base?

a. An acid is an electron pair acceptor while base is an electron pair donor

b. An acid is an electron pair donor while base is an electron pair acceptor

c. An acid is proton donor while base is proton acceptor

d. An acid react with base only at high temperature

14. In a mixture of petrol and water, two separate layers are formed because _____

a. Water is less dense than petrol

b. Of the presence of hydrogen bond

c. Petrol is less dense than water

d. Petrol and water were not mixed thoroughly

15. When yellow and blue are mixed, the colour obtained is

a. Red b. green c. purple d. yellow

16. Chromatography is used in separating one of the following types of mixtures.a. Miscible

b. insoluble c. suspension d. chemicals.

17. Which of the following items listed below is not needed in paper chromatography?

a.Container b. solvent c. water d. paper

18. Sour milk contains

a. Micocondra acid b. citric acid c. lactic acid d. tartaric acid

19. To dilute100cm3 of 5M solution of sulphuric acid solution to 2M you need:

a. 250cm3 of distilled water

b. 500cm3 of distilled water

c. 100cm3 of distilled water

d. 1000cm3 of distilled water

20. Consider the following about acids

i. Strength ii. Concentration iii. Basicity

Which of the following statements is correct?

a. all these refer to the same thing

b. they refer to different thing

c. i & ii refer to the same thing

d. ii & iii refer to the same thing

21. A standard solution is defined as _____

a. A normal solution of acid

b. A molar solution of acid

c. A solution whose concentration is unknown

d. A solution of known concentration in moldm-3

22. In paper chromatography, the spot of mixtures is made on the paper which is then placed in a _____

a. Solvent b. solution c. solute d. salt

23. Fractional distillations is used for separating mixtures of substance with different _____

a. Densities b. boiling points c. specific gravities d. temperature

24. A general way for preparation of salt is by;

a. Neutralization b. Crystallization. Decomposition d. Evaporation

25. Which of the following acids can be called a dibasic acid?

a. Hydrofluoric acid

b. Hydrochloric acid

c. Hydrogen tetraoxosulphate (vi) acid

d. Ethanoic acid

26. Neutralization reaction always produces;-

a. Salt and water b. acid and salt c. acid and base d. water

27. Crystallization, apart from being used for separating mixtures can also use one of the following.

a. Purification b. reduction c. dissolution d. oxidation

28. In chromatography the substance are _____

aDestroyed b. made c. not changed chemically d. separated chemically

29. Crystallization, apart from being used for separating mixtures can also be used in one of the following way

a. Purification b. Reduction c. dissolution d. Oxidation

30 .Which of this equation defines PH

a. PH= -log [H+]b. PH= +log [H]c. PH= -log [OH]d. PH= +log [OH]

Section 11: Provide short answers to the following questions

31 Give a general method of preparation of salt

---

32. List eight (8) separation method you have studied.

a._____ b. _____

c._____ d. _____

e._____ f. _____

g._____ h. _____

33. Define buffer solution_____

34.A suitable indicator for titrationofhydrochloricacidagainstaqueousammonia iscalled _____

35. What is a mixture _____

APPENDIX II

MARKING SCHEME OF CHEMISTRY ACHIEVEMENT TEST.

Section 1

1. A
2. C
3. B
4. B
5. B
6. B
7. D
8. C
9. D
10. C
11. A
12. D
13. A
14. C
15. B
16. C
17. C
18. C
19. A
20. B
21. D

22. A

23. D

24. A

25. C

26. A

27. A

28. D

29. A

30. A

Section 2

31. The general method for preparation of salt is by neutralization

32. Eight methods that can be used for separation of mixtures are:

a. decantation b. chromatography

c. filtration d. fractional distillation

e. sublimation f. evaporation

g. crystallization h. separating funnel

33. A buffer solution is a solution of weak acid and its conjugate base

34. A suitable indicator for titration of hydrochloric acid against aqueous ammonia is Methyl indicator

35. A mixture can be defined as a substance that contains two or more elements or compounds each of which retain its characteristics, properties (chemical identities) and can be separated by physical process.

Appendix 3

Experimental Group

Lesson One

Subject: Chemistry

Topic: Separation Techniques

Sub topic: Nature of Matter

Class: SS II

Sex: Females and Males

Date: 12th may, 2014

Number In class: 30, 30

Time duration: 1hr 10 Minutes

BEHAVIORAL OBJECTIVES: At the end of the lesson, the students should be able to:

I. identify matter

II. Describe the properties of matter

III. Classify Matter

PREVIOUS KNOWLEDGE: The students have known from experience that there are plants and animals around the universe.

Materials: stove, food, water, sugar paper and so on

INTRODUCTION: The students were asked to stand up and breathe in and out and explain how they feel

PRESENTATION: step 1 the teacher led the students to identify matte|: matter is anytime that have weight and occupy space everything in the universe is made up of matter.

Activity 1.1: Pick a stone and tell me what you feel

Expected Answer: It is heavy

Activity 1.2: Remove your shoe and place it on your palm, do you feel anything?

Expected Answer: yes, l did l felt the weight.

Examples of Matter are stones, food, water, plants and even animals. This is because they all possess their kinds of weight and occupy space

Activity 1.3: The teacher asked the students to do the following: inquire about 10 things that have weight and occupy space.

STEP II: The teacher describes the properties of matter.

The proper of matter includes physical properties and chemical properties.

Activity 1.4: what is the colour of the this paper

Expected Answer: It is white in colour. The teacher asked one of the students to light a match stick and burn up the paper

Expected Observation: The paper burns into ashes

The white colour of the paper is its physical property while the ashes are the chemical proper and this chemical proper is irreversible.

Activity 1.5: pick up a stick and note the colour burn it up and record your observations.What is it physical and chemical properties?

The physical properties are associated with physical observation. For example, boiling point, matting point, hardness, colour and so on. While chemical properties are those properties which are involved when matter undergo a change to form new substance

Step III: The Teacher Classify matter

Matter is classified into two forms i.e. physical change and chemical change.

Physical change	Chemical change
It is easily reversible	It is not easily reversible
No new substances are formed	New substance are formed entirely

Activity 1.6:inquire: what happens to sugar when heated? Does it undergo a chemical change or not?

Put a little quantity of sugar into a pettish dish. Light up your bursen burner and heat up for some minutes'

Observation: the sugar burns to give a black residue (carbon). The sugar

Cannot be recovered when water is added to the black residue

EVALUATION: The teacher evaluates the class by asking the following questions:

I. Identify matter

II. Describe the properties of matter

III. Classify Matter

CONCLSION: The teacher concludes the lesson by giving the students take home work.

LESSON TWO

Subject: Chemistry

Topic: Separation Techniques

Sub Topic: Elements, Compounds and Mixture

Class: SS II

Sex: Females and Males,

Date: 19th May, 2014

Number in class: 30, 30

Time Duration: 45minutes

Behavioural Objective: At the end of the lesson, the students should be able to:

1. classify matter into elements, compounds and mixture
2. differentiate between element, compound and mixtures

Previous Knowledge: The students have learnt that everything in the universe is made up of matter

Introduction: The teacher introduced the lesson by asking them question from their previous knowledge.

Presentation: The teacher presents the lesson using the following steps;

Step 1. The teacher classify matter into elements, compounds and mixture

Step2. The teacher differentiate between element, compound and mixtures

Evaluation: The teacher evaluates the lesson by asking the students the following questions;

1. Classify matter into elements, compounds and mixture

2. Differentiate between element, compound and mixtures

Conclusion: The teacher concludes the lesson by giving the students home work

LESSON THREE

Subject: Chemistry

Topic: Separation Techniques

Sub Topic: Types of Separation Techniques

Class: SS II

Sex: Females and Males,

Date: 26th May, 2014

Number in class: 30, 30

Time Duration: 60minutes

Behavioural Objective: At the end of the lesson, the students should be able to:

1. list and explain all the separation techniques
2. separate pure samples of constituent of mixtures

Materials: filter paper, sand, funnel etc.

Previous Knowledge: the students have been taught mixture

Introduction: the students were asked question from their previous lesson

Presentation: the teacher presents the lesson in the following steps:

Step 1: the teacher list and explain the eleven separation techniques

There are eleven separation techniques and they are:

1. chromatography" to separate colours
2. filtration: to separate liquid from solids
3. evaporation: to separate insoluble solution

4. simple instillation
5. decantation
6. fractional distillation
7. magnetic separation

Step 2. The teacher separates led the students to separate pure samples of constituents of mixture.

Activity 1.7: simple filtration: the teacher asked the students to pick up an empty milk tin container each and put two leveled full teaspoon of sand and add water to half the container

Observations:the sand did not dissolves in the water.

Put a filter paper into a funnel and pour in the mixture of sand and water

Observation: the water was filtered through the filter paper leaving in the filter paper the sand. The teacher explains the water which ran through the filter paper as filtrate while the sand in the filter paper as residue

Activity 1.8: Magnetic separation: the teacher asked the students to separate magnetic substances from no-magnetic substance.

The teacher provided magnets tailoring pins and sand. The teacher asked the students to mix the sand and pins together and find the possible means of separating the mixture.

Activity 1.9: Evaporation.

Mix water and sugar together.

Observation: the sugar dissolves in water giving a soluble solution. Heat the solution slightly under light and record your observation.

Activity: inquire how you can obtain fairly pure sample of the constituents of a mixture of common salt and sand.

Method: add distilled water to the mixture and stir. Filter the mixture and dry the solids found on the filter paper. Evaporate the filtrate by heating it gently. Expected Result: the salt dissolves in the water to form a solution. The sand is insoluble and collects on the filter paper, while the salt is then recovered from the filtrate by evaporation

Evaluation: how can you separate Gari and water?

Conclusion: the teacher concludes the lesson by going round to help correct the students answer to the evaluation questions.

LESSON FOUR

Subject: Chemistry

Topic: Acids

Sub Topic: Elements, Compounds and Mixture

Class: SS II

Sex: Females and Males,

Date: 2nd June, 2014

Number in class: 30, 30

Time Duration: 45minuiess

Behavioural Objective: At the end of the lesson, the students should be able to:

1. define an acid

2. identify an acid
3. describe the reaction of acid with metals

Materials: Acid, water, Litmus paper, Lemon Juice and so on

PreviousKnowledge: the students are used to soft drink, lime, oranges, milk and so on

Introduction: The teacher introduces the lesson by asking the students to cut and taste some lime and explain what it taste like.

Presentation:

Step 1: The teacher defines as acid as a substance which produces hydrogen ions as the only positive ion when dissolved in water.

Step 2. The teacher explains and led the students on how to recognize the present of acid.

An acid can be recognized by its sour taste. E.g in some fruits such as lime and lemon.

Acids are class classified into organic acid and mineral or inorganic acids.

Organic acids can be occur from natural products in plants or animal materials or inorganic acids can be prepared from mineral elements or inorganic matter

Inquire: Dilute milk and learn it for some days without preservation it gets sour the sour taste indicate the presence of an acid which is organic in nature and called lactic acid.

Activity 1.10: get an unripe fruit of orange and taste it. How does it taste?

ExpectedAnswer: it's sour. Do you think it acidic or not.

Answer: it is acid because t taste sour and the acid is called ascorbic acid

Activity1.11: Dilute a small quantity of acid in water and taste. It has a sour taste of unripe fruit, vinegar and rancid milk due to the presence of acids in them

Step 7: The teacher describes the reaction of acid with metals

Acids reacts with some metals like Zinc, iron, magnesium to liberate hydrogen gas, such reactions are due to the displacement of the hydrogen ions in the acids by the metals

Acid + metal $\longrightarrow$ salt + hydrogen

$2Hcl + Zn\ (s) \longrightarrow Zncl_2(_{aq}) + H_2\ (g)$

Evaluation: The teacher evaluates the lesson by asking them the following questions:

1. define an acid
2. identify an acid in the following given samples
3. describe the reaction of acid with metals

Conclusion: The teacher concludes the lesson by giving the students home work

LESSON FIVE

Subject: Chemistry

Topic: Base

Class: SS II

Sex: Females and males

Date: 9th June, 2014

Number in class: 30, 30

Time: 1hour

BehaviouralObjective: At the end of the lesson, the students should be ableto:

1. Define base
2. Observe and explain the reaction of base with acid
3. Carryout acid-base titration

PreviousKnowledge: The students are familiar with acid

Materials:base, acid, pipette, burette, tripod stand, conical flask

Introduction: The teacher introduces the lesson by asking thestudents questions based on their previous knowledge

Presentation: The teacher presents the lesson in the followingsteps:

Step I:The teacher defines base as a substance which will

neutralize an acid to yield a salt and water only

Step II: The teacher led the students to observe and explainthe reaction of base with acid

Activity; Get a little quantity of base (alkali) and mix it up with acid and observe

Observation: Acid + alkali (base) salt + water $Hcl_{(aq)}$ + $NaH_{(aq)} \rightarrow Na^{+} Cl^{-}{}_{(aq)} + H_2O_{(aq)}$

During the reaction, the hydrogen ion, H^{+}, from theacid is neutralized by the hydroxide ion, OH^{-} from the alkali to form the water molecule, H2O

Activity: The teacher led the students to carryout a basereaction withacide.g. NaoH(aq) + $\longrightarrow$

NH_4NO_z (aq) $NaNO_z$(aq) +

$H_20(1) + H20_{(1)} + NIT_3$ (g)

Step III: The teacher led two students to carryout acid-base titration.

Activity: Get 25cm^3 of base in a pipette put in a conical flask and run it through with 50cm^3 of acid from burette The solution gives a particular colour using methyl orange as indicator.

Observation:The solution turns light pink. During a titration,there

is change in PH as the acid is added to the alkali.

Evaluation:The teacher observe the students as they carryout more titration.

LESSON SIX

Subject: Chemistry

Topic: Salts

Class: SS II

Sex: Females and Males

Date: 16th June, 2014

Number in Class: 30, 30

Time: 45minutess

Behavioural Objectives: At the end of the lesson, the students should be able to:

1. Define Salts.
2. Prepare various types of salts

Previous Knowledge: The students are familiar with table salt.

Materials: Salt, Water, chemicals

Introduction: **T**he teacher introduces the lesson by asking questions based on the student's previous knowledge.

Presentation: The teacher presents the lesson in the following steps:

Step I: The teacher defines salts. In science**,** salts refers to a chemical compoundformed by replacing the hydrogen ions in an acid metallic or ammonium ionsit is the only product formed, besides water , when an acidreact with a base.

Step II: The teacher led the student in the preparation of different type of salt. The method chosen for preparing a particular salt depends largely on:

- It's Solubility in water, and
- It's stability to heat

Evaluation: The teacher evaluates the lesson by asking the students the following questions;

1. Define salt
2. How can salts be prepared?

Conclusion: The teacher concludes by going over the lesson again.

CONTROL GROUP

LESSON ONE

Subject: Chemistry

Topic: Separation techniques

Sub Topic: Nature of Matter

Class: SS II

Sex: Females and Males

Date: 23rd June, 2014

Number in Class: 30, 30

Time: 45minutes

Behavioural Objectives: At the end of the lesson, the students should be ableto:

1. Identify matter
2. Describe the properties of matter
3. Classify matter.

Previous Knowledge: The students have known from experience that there are plants and animals around the universe.

Introduction: The students were asked to stand up and breath inand out and explain how they felt.

Presentation"

Step I: The teacher identify matter as anything that have weight and occupy space e.g. food, water, shoe etc.

Step II: The teacher describes the properties e.g. colour of an objectand (II) chemical properties e.g. the change that the physical object undergoes.

Step III: The teacher classifies matter. Matter is classify in two forms i.e. physical change and chemical change.

Physical change	**Chemical change**
It is easily reversible	It is not easily reversible

No new substance are formed	New substance are formed

Evaluation: The teacher evaluates the lesson by asking the students the following question;

1. Identify 10 matter in the classroom
2. Describe the properties of matter
3. Classify matter into its form.

Conclusion: The teacher concludes by giving the studentsclass work.

LESSON TWO

Subject: Chemistry

Topic: Separation Technique

Sub topic: Element, Compounds and Mixtures

Class: SS II

Date: 30th June, 2014

Sex: Females and Males

Number in Class: 30, 30

Time: 45minutes

Behavioural Objectives: At the end of the lesson, the students should be ableto:

1. Classify matter into element, compound and mixture.
2. Differentiate between element compound and mixture.

Introduction: The students were asked questions from their previous lesson.

Presentation: The teacher presents the lesson using the following steps;

Step 1. The teacher classify matter into elements, compounds and mixture

Step2. The teacher differentiate between element, compound and mixtures

Evaluation: The teacher evaluates the lesson by asking the students the following questions;

1. Classify matter into elements**,** compounds and mixture

2. Differentiate between element, compound and mixtures

Conclusion: The teacher concludes the lesson by giving the students home work

LESSON THREE

Subject: Chemistry

Topic: Types of separation Technique

Class: SS II

Date: 7th July, 2014

Sex: Females and Males

Number in Class: 30, 30

Time: 45mins

Behavioural Objectives: At the end of the lesson, the students should be able to:

1. List all the separation techniques.
2. Separate pure samples of constituents of mixtures.

Previous Knowledge: The students are familiar with mixtures

Introduction: The students were asked questions from on their Previous lessons

Presentation: The teacher presents the lesson in the following Steps:

Step i: The teacher list all the separation techniques;

They include filtration, evaporation, simple Distillation, fractional distillation, decantation, Magnetic separation, extraction, sublimation, Crystallization, paper chromatography andseparating funnel

Step ii: The teacher taught how to separate pure samples of Constituents of **Mixtures**:Mixtures of water and sand can be separated

With simple filtration. When water and sand are mixed together, water can be filtered from the unmixable solution through a filter paper. Mixture of sugar and water can be separated by evaporation through the application of heat to the soluble solution.

Evaluation: The teacher evaluates the lesson by asking the students the following questions;

1. List all the separation techniques.
2. Separate pure samples of constituents of mixtures.

Conclusion: The teacher concludes the lesson by giving the students home work.

LESSON FOUR

Subject:	Chemistry
Topic:	Acids
Class:	SS II
Date:	14th July, 2014
Sex:	Females and Males
Number in Class:	30, 30
Time:	45minutes

Behavioural Objectives: At the end of the lesson, the students should be able to:

1. Define acids.
2. Identify an acid.

3. Recognize how an acid behaves in solution.
4. Describe the reaction of acid with metals.

Previous knowledge: The students are used to soft drink, lime and lemon.

Introduction: The teacher asked the students to taste lime andexplain how it tastes.

Presentation:

Step i:The teacher defines an acid as a substance which produces hydrogen ions when dissolved in water.

Step ii: The teacher explained how to recognize an acid; An acid can be recognized by its sour taste.

Step iii: The teacher explains how an acid behaves in a solution; An acid changes blue litmus paper to red

Step iv: The teacher describes the reaction of acids withmetals.Acids reacts with some metals to liberatehydrogen gas.

Evaluation: The teacher evaluates the lesson by asking the students the following questions:

1. Define acids.
2. Identify an acid.
3. Recognize how an acid behaves in solution.
4. Describe the reaction of acid with metals.

Conclusion: The teacher concludes the lesson by giving the students home work

LESSON FIVE

Subject: Chemistry

Topic: Base

Class: SS II

Date: 21st July, 2014

Sex: Females and Males

Number in Class: 30, 30

Time: 45minutes

Behavioural Objectives: At the end of the lesson, the students should be able to:

1. Define base.
2. Describe the reaction of base with acid.
3. Carry out acid-base titration

Previous knowledge: The students are familiar with acids

Introduction: The students were asked questions from their previous knowledge

Presentation: The teacher presents the lesson in the following Ways;

Step i: The teacher defines base as a substance which will neutralize an acid to yield salt and water only

Step ii. The teacher describes the reaction of base with acid.

All base reacts with acid to form salt andWater.

Step iii. The teacher explains acid base titration.

Evaluation: The teacher evaluates the lesson by asking the students the following questions;

1. Define base.
2. Describe the reaction of base with acid.
3. Carry out acid-base titration

Conclusion: The teacher concludes the lesson by giving the students homework.

LESSON SIX

Subject: Chemistry

Topic: Salts

Class: SS II

Sex: Females and Males

Date: 28th July, 2014

Number in Class: 30, 30

Time: 45mins

Behavioural Objectives: At the end of the lesson, the students should be able to:

1. Define Salts.
2. Explain how to Prepare various types of salts

Previous Knowledge: The students are familiar with table salt.

Introduction: The teacher introduces the lesson by asking questions based on the student's previous knowledge.

Presentation: The teacher presents the lesson in the following steps:

Step I:The teacher defines salts. In science**,** salts refers to a chemical

Compound formed by replacing the hydrogen ions in an acid with metallic or ammonium ions. It is the only product formed, besides water, when an acidreact with a base.

Step II: The teacher explains the preparation of various type of salts . The method chosen for preparing a particular salt depend largely on:

- It's Solubility in water, and
- It's stability to heat.

Evaluation: The teacher evaluates the lesson by asking the students the following questions;

1. Define Salts.

2. Explain how to prepare any type of salt you know.

Conclusion: The teacher concludes the lesson by giving the students home work.

Appendix4

Reliability: Effect of inquiry method and Traditional method on Academic performance of Chemistry Students in Senior Secondary Schools in Zaria Inspectorate Division in Kaduna state.

S/N	X	Y	X^2	Y^2	XY
1	30	32	900	1024	960
2	30	34	900	1156	1024
3	40	42	1600	1764	1680
4	20	26	400	676	520
5	32	30	1024	900	960
6	40	44	1600	1936	1760
7	26	28	676	784	728
8	40	42	1600	1764	1680
9	34	32	1156	1024	1088
10	28	30	784	900	840
11	40	42	1600	1764	1680
12	42	42	1764	1764	1764
13	48	46	2304	2116	2208
14	38	40	1444	1600	1520
15	40	52	1600	2704	2080
16	38	44	1444	1936	1672

17	28	26	784	676	728
18	40	42	1600	1764	1680
19	36	40	1296	1600	1440
20	28	32	784	1024	896
N=20	**$\sum X=698$**	**$\sum Y=746$**	**$\sum X^2=25263$**	**$\sum Y^2=28876$**	**$\sum XY=26908$**

Appendix 4: Raw scores of the two sets of tests for determining the coefficient of reliability of the test instrument.

APPENDIX (Statistics for finding reliability)

Pearson Product Moment Correlation computed for the Reliability index for the instrument used in the pilot study of the research.

The formula for Pearson Product Moment Correlation is given below:

$$R = \frac{N(\sum xy) - \sum X \sum Y}{\sqrt{((N\sum X^2) - (\sum X)^2)\ (N\sum Y^2)-(\sum Y)^2)}}$$

Where:

N=Number of respondents

X is test scores at first administration

Y is test scores at second administration

$\sum x$ is scores at first administration is summed

$\sum y$ is scores at second administration is summed

$\sum x$ is scores at first administration is squared and summed

$\sum Y$ is scores at second administration is squared and summed

$(\sum x)^2$ is scores at first administration is summed and squared

$(\sum Y)^2$ is scores at second administration is summed and squared

Therefore,

N=20, $\sum X$=698, $\sum Y$=746, $\sum X^2$=25263, $\sum Y^2$=28876, $\sum XY$=26908

Substituting the values in the formula above

$$N = \frac{20*26908 - 698*746}{\sqrt{20*(25263) - (698)^2 \ (20*28876 - (746)^2)}}$$

r=.8

Frequency Table

Location

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Urban	60	50.0	50.0	50.0
	Rural	60	50.0	50.0	100.0
	Total	120	100.0	100.0	

Sex

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	63	52.5	52.5	52.5
	female	57	47.5	47.5	100.0
	Total	120	100.0	100.0	

School

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	GSS Magajiyya	29	24.2	24.2	24.2
	GSS Dakachi	30	25.0	25.0	49.2
	GSS Tudun Saibu	30	25.0	25.0	74.2
	GSS Yakasai	30	25.0	25.0	99.2
	11.00	1	.8	.8	100.0
	Total	120	100.0	100.0	

Group

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Experimental	60	50.0	50.0	50.0
	Control	60	50.0	50.0	100.0
	Total	120	100.0	100.0	

Hypo1

T-Test

Group Statistics

	group	N	Mean	Std. Deviation	Std. Error Mean
Acdemic_performance	Experimental	60	52.7417	8.50697	1.09825
	control	60	48.5167	8.47627	1.09428

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Acdemic_performance	Equal variances assumed	.221	.639	2.725	118	.007	4.22500	1.55035	1.15488	7.29512
	Equal variances not assumed			2.725	117.998	.007	4.22500	1.55035	1.15488	7.29512

Hypo2

T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	50.4500	60	9.21573	1.18975
	Posttest	55.0333	60	8.49520	1.09673

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	pretest & posttest	60	.845	.000

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	pretest – posttest	-4.58333	4.97210	.64189	-5.86776	-3.29890	-7.140	59	.000

Hypo3

T-Test

Group Statistics

	sex	N	Mean	Std. Deviation	Std. Error Mean
Acdemic_performance	male	36	52.7222	10.19905	1.69984
	female	24	52.7708	5.22947	1.06746

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means					
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
								Lower / Upper

Acdemic_performance	Equal variances assumed	13.102	.001	-.021	58	.983	-.04861	2.26102	-4.57453	4.47731
	Equal variances not assumed			-.024	55.026	.981	-.04861	2.00722	-4.07113	3.97391

Hypo3

Group Statistics

	location	N	Mean	Std. Deviation	Std. Error Mean
Acdemic_performance	urban	30	52.4500	8.60969	1.57191
	rural	30	53.0333	8.53990	1.55917

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper

S/NO	LOCATION	SEX	SCHOOL	GROUP	PRETEST	POSTEST

Acdemic_performance	Equal variances assumed	.004	.952	-.263	58	.793	-.58333	2.21402	-5.01518	3.84851
	Equal variances not assumed			-.263	57.996	.793	-.58333	2.21402	-5.01518	3.84852

1	URBAN	MALE	1	EXP	56	64
2	URBAN	MALE	1	EXP	54	63
3	URBAN	MALE	1	EXP	56	59
4	URBAN	MALE	1	EXP	70	78
5	URBAN	MALE	1	EXP	56	60
6	URBAN	MALE	1	EXP	65	69
7	URBAN	MALE	1	EXP	67	70
8	URBAN	MALE	1	EXP	45	55
9	URBAN	MALE	1	EXP	39	44
10	URBAN	MALE	1	EXP	43	52
11	URBAN	MALE	1	EXP	35	47
12	URBAN	MALE	1	EXP	41	50
13	URBAN	MALE	1	EXP	42	43
14	URBAN	MALE	1	EXP	52	54
15	URBAN	MALE	1	EXP	34	40
16	URBAN	MALE	1	EXP	45	50
17	URBAN	MALE	1	EXP	41	47
18	URBAN	MALE	1	EXP	54	56
19	URBAN	MALE	1	EXP	54	57
20	URBAN	MALE	1	EXP	45	48
21	URBAN	FEMALE	1	EXP	50	53
22	URBAN	FEMALE	1	EXP	47	52
23	URBAN	FEMALE	1	EXP	45	48
24	URBAN	FEMALE	1	EXP	54	56
25	URBAN	FEMALE	1	EXP	62	66

26	URBAN	FEMALE	1	EXP	45	58
27	URBAN	FEMALE	1	EXP	52	56
28	URBAN	FEMALE	1	EXP	48	51
29	URBAN	FEMALE	1	EXP	44	48
30	URBAN	FEMALE	1	EXP	55	57
31	URBAN	MALE	2	CONTROL	53	53
32	URBAN	MALE	2	CONTROL	54	56
33	URBAN	MALE	2	CONTROL	56	58
34	URBAN	MALE	2	CONTROL	67	67
35	URBAN	MALE	2	CONTROL	52	52
36	URBAN	MALE	2	CONTROL	61	60
37	URBAN	MALE	2	CONTROL	62	63
38	URBAN	MALE	2	CONTROL	45	46
39	URBAN	MALE	2	CONTROL	40	40
40	URBAN	MALE	2	CONTROL	41	40
41	URBAN	MALE	2	CONTROL	32	35
42	URBAN	MALE	2	CONTROL	40	41
43	URBAN	FEMALE	2	CONTROL	38	40
44	URBAN	FEMALE	2	CONTROL	52	53
45	URBAN	FEMALE	2	CONTROL	34	35
46	URBAN	FEMALE	2	CONTROL	45	42
47	URBAN	FEMALE	2	CONTROL	41	40
48	URBAN	FEMALE	2	CONTROL	54	52
49	URBAN	FEMALE	2	CONTROL	54	54
50	URBAN	FEMALE	2	CONTROL	45	46

51	URBAN	FEMALE	2	CONTROL	50	51
52	URBAN	FEMALE	2	CONTROL	47	48
53	URBAN	FEMALE	2	CONTROL	45	44
54	URBAN	FEMALE	2	CONTROL	54	57
55	URBAN	FEMALE	2	CONTROL	62	63
56	URBAN	FEMALE	2	CONTROL	45	46
57	URBAN	FEMALE	2	CONTROL	52	53
58	URBAN	FEMALE	2	CONTROL	44	45
59	URBAN	FEMALE	2	CONTROL	41	44
60	URBAN	FEMALE	2	CONTROL	46	36
61	RURL	MALE	3	EXP	58	68
62	RURL	MALE	3	EXP	53	64
63	RURL	MALE	3	EXP	55	57
64	RURL	MALE	3	EXP	69	76
65	RURL	MALE	3	EXP	55	59
66	RURL	MALE	3	EXP	65	69
67	RURL	MALE	3	EXP	67	70
68	RURL	MALE	3	EXP	45	55
69	RURL	MALE	3	EXP	39	44
70	RURL	MALE	3	EXP	43	52
71	RURL	MALE	3	EXP	35	47
72	RURL	MALE	3	EXP	41	50
73	RURL	MALE	3	EXP	42	43
74	RURL	MALE	3	EXP	52	54
75	RURL	MALE	3	EXP	34	40

76	RURL	MALE	3	EXP	45	50
77	RURL	FEMALE	3	EXP	41	47
78	RURL	FEMALE	3	EXP	54	56
79	RURL	FEMALE	3	EXP	54	57
80	RURL	FEMALE	3	EXP	45	48
81	RURL	FEMALE	3	EXP	50	53
82	RURL	FEMALE	3	EXP	47	52
83	RURL	FEMALE	3	EXP	45	48
84	RURL	FEMALE	3	EXP	54	56
85	RURL	FEMALE	3	EXP	62	66
86	RURL	FEMALE	3	EXP	45	58
87	RURL	FEMALE	3	EXP	52	56
88	RURL	FEMALE	3	EXP	56	51
89	RURL	FEMALE	3	EXP	70	48
90	RURL	FEMALE	3	EXP	58	57
91	RURL	MALE	4	CONTROL	60	53
92	RURL	MALE	4	CONTROL	50	56
93	RURL	MALE	4	CONTROL	53	58
94	RURL	MALE	4	CONTROL	64	67
95	RURL	MALE	4	CONTROL	55	57
96	RURL	MALE	4	CONTROL	65	69
97	RURL	MALE	4	CONTROL	62	64
98	RURL	MALE	4	CONTROL	45	46
99	RURL	MALE	4	CONTROL	40	40
100	RURL	MALE	4	CONTROL	41	40

101	RURL	MALE	4	CONTROL	32	35
102	RURL	MALE	4	CONTROL	40	41
103	RURL	MALE	4	CONTROL	38	40
104	RURL	MALE	4	CONTROL	52	53
105	RURL	MALE	4	CONTROL	34	35
106	RURL	FEMALE	4	CONTROL	45	42
107	RURL	FEMALE	4	CONTROL	41	40
108	RURL	FEMALE	4	CONTROL	54	52
109	RURL	FEMALE	4	CONTROL	54	54
110	RURL	FEMALE	4	CONTROL	45	46
111	RURL	FEMALE	4	CONTROL	50	51
112	RURL	FEMALE	4	CONTROL	47	48
113	RURL	FEMALE	4	CONTROL	45	44
114	RURL	FEMALE	4	CONTROL	54	57
115	RURL	FEMALE	4	CONTROL	50	53
116	RURL	FEMALE	4	CONTROL	46	46
117	RURL	FEMALE	4	CONTROL	52	53
118	RURL	FEMALE	4	CONTROL	44	45
119	RURL	FEMALE	4	CONTROL	41	44
120	RURL	FEMALE	4	CONTROL	46	36