

**EFFECTS OF INQUIRY TEACHING METHOD ON ACADEMIC ACHIEVEMENT,
RETENTION AND ATTITUDES TOWARDS CHEMISTRY AMONG DIPLOMA
STUDENTS OF KANO STATE POLYTECHNIC**

BY

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DECLARATION

I hereby declare that this thesis titled “Effects of Inquiry Teaching Method on Academic Achievement, Retention and Attitudes Toward Chemistry Among Diploma Students of Kano State Polytechnic” has been written by me and that it is a record of my own research work. It has not been presented in any previous application for higher degree. All quotations are indicated by quotation marks or indentation and the sources of the information are specifically acknowledged by means of references

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CERTIFICATION

This thesis entitled “Effects of Inquiry Teaching Method on Academic Performance, Attitude and Retention Among Diploma Students of Kano State Polytechnic” by Suleiman Ali Muhammad meets the regulations governing the award of the Masters’ Degree in Science Education of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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OPERATIONAL DEFINITIONS OF TERMS

Inquiry Teaching Method: is a style or method of teaching where the learner discovers and creates answers to recognized problem through procedure of making a diligent search.

Lecture Method is a pedagogical strategy in which a lecturer presents his lesson to a large number of students verbally but with little participation from the students.

Academic Performance: A measure of what a person has accomplished after exposure to an educational programmed.

Retention means the ability remember learned concept of information over some period of time, this time period is called retention interval.

Attitudes Attitude is an emotional state of individual towards an object or situation

Gender is defined as the amount of masculinity and feminity found in a person.

ABSTRACT

This study investigated effects of inquiry and lecture methods of teaching on students' academic achievement, retention and attitude among diploma two chemistry students of Kano State Polytechnic. The study is a pre test, post test quasi experimental control group design. A total of seventy (70) students form the sample of the study. Two instruments, namely Chemistry Achievement Test (CAT) and Chemistry Attitude Questionnaire (CAQ) were use for data collection. The CAT was develop by the researcher and validated by experts in chemistry education and psychology. The reliability coefficient of CAT and CAQ were found to be $r=0.785$ and $r=0.82$ respectively. Analysis of data using t-test statistic and weight average revealed that the experimental group which was taught chemistry using inquiry teaching methods performed significantly better than the control group which was taught using the traditional lecture method and that the experimental group developed positive attitudes toward chemistry after exposure to the inquiry teaching method. Other finding of research was that inquiry method of instruction was gender-friendly and that is enhances retention. The study recommends, among others, that chemistry teachers should be encouraged to use inquiry method in the teaching of chemistry.

CHAPTER ONE

THE PROBLEM

1.1 Introduction

One of the objectives of science education is to develop students' interest towards science and technology. The development of any nation today depends on its technological and scientific advancement. Teachers are expected to devise ways of motivating their students to develop positive attitudes towards science and science related disciplines (Sola & Ojo, 2007).

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, Clark & Kelloough, 1995). Inquiry teaching method is also a term used in science teaching that refers to a way of questioning, seeking knowledge or information or finding out about phenomena, it involves investigating data and arriving at a conclusion (Sola & 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. According to Sola and Ojo (2007), inquiry is a way people learn when they are left alone.

Cheval and Hart (2005) classify inquiry teaching method in to three classes, namely: structured inquiry, guided inquiry and open inquiry,

as illustrated in Table 1. There is a debate as to which type of inquiry is best. The general consensus is that, any form of inquiry (structured, guided, or open) can be useful to students when taught appropriately well. 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 & Hart, 2007).

On the far side of the spectrum is an open inquiry. This type of inquiry requires the least amount of teacher intervention and is student-centered. Students often work in groups and plan all phases of their investigations. This is the purest form of inquiry conducted in science classrooms (Cheval & Hart, 2005).

Guided inquiry falls in the middle of the inquiry instructional spectrum. This approach 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) summarized these inquiry types in Table 1. 1

Table 1.1 Summaries of Inquiry Types*

Types of inquiry	Description	Example
Structure inquiry	Teacher gives students problems to investigate during hands on activities as well as the procedures and materials. Students must determine the outcome	Laboratory activities with procedures materials and question specified
Guided inquiry	Teachers give students the problem or question and materials. Students have to determine the process and outcome	Students are given problems or questions what are the properties of an acid what are the properties of a base etc.
Open inquiry	The students determine the problems procedures and outcome	Students took a field trip to investigate garden. Working with a partner must identify research problems and conduct an investigation based on the observation

***Source (Cheval & Hart, 2005)**

In this study guided inquiry was used and students were given topics and materials they developed method to find answers to the problem given to them.

Lecture method is used primarily to introduce students to a new subject but it is also a valuable method for summarizing ideas, showing relationship between theory and practice and re-emphasizing main points (Sola & Ojo, 2007). Lecture-demonstration method is a teaching technique that combines oral presentation with doing to communicate process,

concepts ideas and facts, observation. It is particularly effective in teaching a skill that can be observed (Sola & Ojo, 2007).

According to Garba (1996), lecture method is a traditional method of transmission of knowledge; it is characterized by a one-way flow of information from the teacher who is always active to the learners who are always passive. According to him, lecture method has the following characteristics:

- (i) Large class size which may range from 25 – 100, it is appropriate for higher secondary students and students of tertiary institutions.
- (ii) May be supported with visual aids, film or lecture handouts.
- (iii) Students are absolutely passive listeners and passively assimilating information/fact being given to them.
- (iv) Students are responsible for making their own notes.
- (v) Teacher or lecturer does the major activities i.e. talking, illustration or presentation of the film or other aid.

Lecture method is noted for the following merits:

- (i) Knowledge, facts or information are transmitted to students who gain some understanding of a subject.
- (ii) It is less expensive compared to the inquiry methods.

However, lecture method has its own short comings, which include the following:

- (i) Passive learning on the part of the students and this makes them weak and disinterested.
- (ii) No immediate evaluation is made of what has been learned.
- (iii) Soft-spoken teacher/ instructor could create a breakdown in the communication this is because some students may lose interest in his lecture.

Inquiry teaching method was chosen in this study due to its scientific nature and it is student- centered and it involved all scientific process (Sola & Ojo 2007). In this study, the effects of inquiry teaching method on academic achievement, retention and attitudes of Diploma students of Kano State Polytechnic towards chemistry was investigated.

Retention means storage of information over some period of time, this time period is called retention interval (Bichi, 2002). If for some reasons, the subject is unable to produce the response at the end of the retention interval forgetting has occurred. The more active the learner is in the leaning process the better he or she retains what is taught (Paul, 1999). According to Johnson and Johnson (1990), learning through inquiry activities enhances elaborative thinking and better understanding which lead to more meaningful learning. This has the potential of increasing depth of understanding, the quality of reasoning and the accuracy of long term retention. In this study the effectiveness of inquiry teaching method on retention ability of the students was investigated.

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 involve the object or thing. He went further to assert that attitudes are partially emotional and that they are acquired not innate. 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.

An attitude can either be positive or negative predisposition towards a particular organization and it also involves behavior. Attitude can change from negative to positive or from positive to negative as the case may be. Teaching methods can influence the attitudes of the students towards learning positively or negatively. Stipeck (1995) examined the effects of inquiry teaching method on geology achievement and students attitudes towards science. He indicated that there was an improvement in academic achievement and enhancement of the students' attitudes towards sciences. In this study the effects of inquiry teaching method on the attitudes of the students towards chemistry were investigated.

Gender refers to the amount of masculinity and femininity found in human beings, the normal man has preponderance masculinity and normal

female has preponderance of femininity (Bichi 2002). In recent years several researches have been conducted on gender related issues. Such studies suggested that by the age of eleven, many young stars demonstrated a sex-stereotyped behavior and attitudes (Agboola & Olayede 2007).

In this study an attempt has been made to investigate if inquiry teaching method is gender friendly or not. It is hoped that the find of this study will help science teachers to improve science instruction for both boys and girls.

1.2 Theoretical Framework

According to Russell (2000), constructivism, active learning involves the students doing things by themselves and thinking about things they do enhances learning, improve the retention level and this in turn produces meaningful learning outcome and improve attitude toward learning of science 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, enhances retention level of the students and it is hoped to change the attitude of the students towards chemistry to be positive.

1.3 Statement of the Problem

Chemistry being a core subject in the study of sciences and engineering should be given a special consideration. Many students find chemistry to be a hindrance in attaining their aims and objectives (Donald, 2000). For example; students wishing to read medicine cannot do so unless they perform well in chemistry. It is therefore necessary to properly groom the students and get them improve their academic achievement in chemistry.

To this end, the United Nations Education Scientific and Cultural Organization (UNESCO) and the International Union of Pure and Applied Chemists (IUPAC) have participated in numerous international meetings to promote inexpensive experimental-based teaching in chemistry. (German, 1989).

Poor performance of students in science subjects, particularly chemistry, has assumed a serious dimension as reported by West African Examinations Council (1999). 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 (West African Examinations Council Report, 1999). The same mass failure is being experienced even in our tertiary institutions especially School of Technology of Kano State Polytechnic. This can be seen from the examination results of Department of Science Laboratory Technology, School of Technology, from 1999 – 2004, shown in Table 1.2

Table 1.2 Statistics of Students' Results in Chemistry in Kano State Polytechnic 1999 – 2004.

Session	Total NO. of students enrolled in the programmed	Total NO. of students sat for the examination	Pass	%	Failure	%
1998/1999	65	56	26	40	35	54
1999/2000	84	83	51	64	32	48
2001/2002	119	115	69	60	46	40
2002/2003	123	118	49	42	69	58
2003/2004	182	175	61	35	114	65

Source: Examination Office, Kano State Polytechnic (2004)

Inquiry teaching method have long been employed and prevailed in the mains stream of classroom since National Science Forum Curriculum Reform effort in the late 1950 and early 1960. The inquiry teaching method developed in this study specifically emphasized gathering and interpreting data by the students in cooperative learning setting with the goal of improving students learning of chemistry content. Inquiry teaching method was chosen in this study because; even though it is highly scientific in nature it is seldom practiced in our tertiary institutions (Sola & Ojo, 2007). The Curriculum of National Diploma of 1989 clearly recommends the use of lecture method in the teaching of chemistry (National Board for Technical Education, 1989). This study introduced the use of inquiry teaching in the teaching of chemistry in Kano state polytechnic, with the view of improving the quality of teaching and learning.

Acid, base and salt are important chemicals used in science laboratories. According to Ibrahim, (2006) acid, base and salt form about 85% of the

chemical used in the schools' laboratories the concept should therefore properly understood,

ND II was used in this study because at this level students were well exposed to chemistry courses using traditional lecture method. They are also familiar with school environment, laboratories and the instructors.

1.4 Objectives of the Study

Specifically, the study has the following objectives to:

- (i) determine the effects of inquiry teaching method in the teaching of chemistry among diploma students of Kano state Polytechnic.
- (ii) investigate the retention ability of students taught chemistry with inquiry teaching method
- (iii) investigate the effectiveness of inquiry method on academic performance of male and female students in the learning of chemistry
- (iv) determine the effect of inquiry teaching method on the attitudes of the students towards chemistry.

1.5 Research Questions

The study investigated the following research questions:

- (i) What are the effects of inquiry teaching method on mean scores of Diploma students of Kano State Polytechnic in chemistry?
- (ii) What is the effect of gender on the academic performance of male and female taught acid, base and salt concepts using inquiry teaching method?

- (iii) Does the teaching of acid, base and salt concepts using inquiry teaching method result in greater retention of the learned concepts than using lecture method?
- (iv) Does inquiry teaching method change attitudes of the students towards chemistry?

1.6 Null Hypotheses:

The following null hypotheses were formulated and tested in the course of the study.

H_{O1}: There is no significant difference in means scores of students taught chemistry concepts using inquiry teaching methods and those taught the same concept using lecture method.

H_{O2}: There is no significant difference in means score of male and female students taught acid, base and salt concepts using inquiry teaching method.

H_{O3}: There is no significant difference in retention ability between students taught acid, base and salt concepts using inquiry teaching method and those taught the same concept using lecture method.

H_{O4}: There is no significant change in students' attitude towards chemistry before and after exposure to inquiry teaching method.

1.7 Significance of the Study

The world in general is becoming increasingly scientifically and technologically oriented. Nigeria is also moving in that direction. The role of laboratory technologist in this scientifically developed world can be not be over emphasized. The Laboratory Technicians/Technologist is trained personnel who are trained to handle laboratory equipment in schools, colleges and even universities. They also work in medical laboratories. It is clear that the course is purely practical and not theoretical and one of their major courses is chemistry. In view of these there is need for proper teaching method in order to train people that will be able to do the expected jobs. This study is significant because it is the first of its kind ever conducted in Kano State Polytechnic.

This study geared toward determining the effects of inquiry teaching method on students' academic performance, retention, and attitude towards chemistry. And it also determine whether the inquiry is gender friendly or not, with the view of improving the quality of teaching and learning among Diploma II chemistry students of Kano State Polytechnic.

The finding of this study has the following significance:

- (i) to facilitate understanding of chemistry among Diploma students and enhance the students' academic performance.
- (ii) to be useful to both staff and students of Kano State Polytechnic, Nation board for Technical Education and the general public.

- (iii) It is also hoped that science based organizations like Science Teachers Association of Nigeria (STAN), Mathematics Association of Nigeria (MAN), National Educational Resources Department (NERD) etc will find this finding useful.
- (iv) Furthermore the study is important, because no research of its kind has ever been conducted in this institution.

1.8 Scope of the Study

This study examined the effect of inquiry teaching method on academic performance retention and attitude of students. The research is limited Diploma II students of Kano State Polytechnic. The conclusions of the study were therefore limited to the population from which the samples were selected.

CHAPTER TWO

REVIEW OF LITERATURE

2.1 Introduction

This Study investigated the effect of two teaching methods on academic achievement and retention among Diploma students of Science Laboratory Technology students of Kano State Polytechnic. It also investigated the effect of gender differences on the academic achievement in the teaching of some chemistry concepts i.e. acid, base and salt concepts. In the previous chapter, an attempt was made to outline the problems, the research questions and their corresponding null hypotheses, as well as the objectives and significance of the study.

The concern of this chapter is to examine or review the literature relevant to the study. Specifically, the review is organized and presented under the following sub-headings:

- 2.2 Chemistry in Everyday Life
- 2.3 Acid, Base and Salt Concepts
- 2.4 Gender and Academic achievement in Science
- 2.5 Instructional Strategies in the Teaching of Chemistry
- 2.6 Academic Achievement in Chemistry
- 2.7 Retention
- 2.8 Science Laboratory Technology Programme at a Glance
- 2.9 Attitude and Science Learning

2.9.1 Review of Related Studies

2.9.2 Implications of the Literature Review to the Present Study

2.2 Chemistry in Everyday Life.

Chemistry is one of the three main branches of pure science, the others 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 skill 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 our life today (Ibrahim, 2006). Studying chemical processes around us, such as lightening a match, cooking, burning of fire wood, rusting nails etc. allow man understand his environment and possible changes it may undergo under different conditions (Sola & Ojo, 2005). All the house hold materials, such as soaps and detergents for washing, hair cream and perfumes and majority of cooking utensils, plastic materials for wide variety of uses are all products of chemical process, (Wong, Onyiruka & Akpanis, 2002).

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

- (i) Agriculture, productions of different type of fertilizers and insecticides have been possible by chemical means, these increase food production greatly. The preservation of and storage of food for long periods is made possible as a result of chemicals prepared by chemist and also by means chemical process, so that the food can be exported to a distant places and made available to more people, to fight hunger and malnutrition. Many food substances today are enriched by addition of essential nutrients, (Wong, Onyiruka & Akpanis, 2002).
- (ii) Man-made textile fibers produces as a result of intensive chemical researches has made available a wide range of clothing materials which supplement the scarce natural fibers. Building materials such as, cement steels bricks and tiles are produced by chemical industries. The chemical properties of the materials are known as a result of chemical researches, and these properties can be modified through chemical reaction to suite a certain purposes, (Wong, Onyiruka & Akpanis, 2002).
- (iii) 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 organization, and conducted by chemists. These researches will

continue to find new drugs and also meet the challenges of time. Modern transportation is an essential feature of today's civilization the rapid development from carts pulled by animals to the latest air craft was made possible by chemists producing suitable fuels and structural materials like alloys which are light, strong and heat-resistant , (Wong, Onyiruka & Akpanis, 2002)

- (iv) 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 Service, chemistry teachers and lectures in secondary schools, polytechnics, colleges of education and universities, laboratory assistants in schools and universities are always of increasing demand.

Health Services, pharmacists, nurses medical assistant and laboratory assistants are all students of chemistry, that is to say, they must to have studied chemistry before being able to be what they are (Garba, 2006).

2.3 Acid, Base and Salts

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. According Wikipedia (2009) an acid is defined as a compound that donate 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^-). Examples of bases include sodium hydroxide used in the manufacture of soap, sodium salt and plastics, potassium hydroxide used in the manufacture of dyeing and in electroplating

Salts are compounds formed when all or part 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, this is formed when parts of replaceable hydrogen ions are partially replaced by metal, example potassium hydrogen sulphate ($KHSO_4$). Basic salts are salts containing hydroxide ion OH^- . 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 it consists of group charge atoms e.g. Sodium tetrahydrozincate (II) Na_2ZnOH_4 .

In this study, acid, based and salt concepts were used to investigate the effectiveness of inquiry teaching method on academic performance, retention and attitude formation among Diploma II of science laboratory technology department of Kano State Polytechnic, this is because acid and base is very important concept, according (Bashir, 2005) acid base and salt form about 70% of the chemical use in laboratory and the concept tends to unfriendly because students usually avoid question in the area (Bashir, 2005)

2.4 Instructional Strategies in the Teaching of Chemistry

There are so many instructional strategies used in the teaching of chemistry. Some of these strategies include inquiry method, traditional lecture method, problems solving approach, cooperative learning and project method among others.

Inquiry teaching method has been described as problem solving, critical thinking, reflective inquiry and deductive thinking. It is a method of teaching that involves probing, finding out investigating, analyzing, synthesizing, discovering, evaluating, questioning and thinking (Muhammad, 2007). In another development, inquiry method is defined as

teaching method which heavily depends upon the learner's involvement with the learning task. The method is based on the assumption that the subject is to learn actively by fully participating in the learning task. It is a method that leads to effective learning outcomes which will be meaningful to the learner (Muhammad, 2007)

In this method of teaching, students are encouraged to behave like scientists in the process of their investigation. Therefore, for the students to meaningfully engage in inquiry there is the need for 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.

Inquiry teaching method is one way of making sense out of what we experience and therefore requires thinking, (Blair and Simon 1998). This implies that the method requires putting learners into situation in which they must to be engaged in intellectual operation that constitutes finding out (Muhammad, 2007). Kyle and Gadsden (1996), viewed inquiry teaching method as a strategy of teaching where students examine ideas, existing issues, probe and question them freely, and practice on their own or with little guidance from the teacher. 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 activities.

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 life time”, (Matthias, 1973). By this proverb it means that teaching people how to tackle and solve problems by themselves, becomes an asset which is what the inquiry approach stands for, while solving problems for people, which is what tradition lecture method is known for, is a temporary.

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 reaching method. One of such critiques is Bredderman (1985) who pointed out some disadvantages of inquiry approach to include its time consuming nature. 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 & 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 offered but if used incompetently as fashion it is probably more disastrous to leaning than exclusive reliance of the former methods.

The lecture method is known as the traditional method of transmission of knowledge, it is characterized as a one way flow of information from the lecturer, who is always active to the learners who are always passive. The method is the most frequently used method of instruction (Garba, 1996). The lecture method is indeed an oral presentation intended to present information or teach people about a particular subject. Lectures are used to convey critical information, historical background, theories and equations. According to Donald (2000) Lecture method is the most frequently used method in teaching.

However presentation of lecture without pausing for interaction with students can be ineffective regardless of the skill of the lecturer. The use of pauses during the lecture for interaction or questions create an interaction between instructor and students, the lecture method is used primarily to introduce students to a new subject, but it is also a valuable method for summarizing ideas, showing relationship between theory and practice and re-emphasizing certain points (Sola & Ojo, 2005)

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 (Sola & Ojo, 2005). A skill-full educator may wish to both tell and show what steps to take in an educational process. A demonstration is usually accompanied by explanation which is essentially a lecture.

On the other hand the demonstration performance method of teaching is based on simple but sound principle that we learn by “doing”, according to (Garba, 1996) the lecture method is a traditional method of transmission of knowledge. It is characterized by a one way flow of information from the teacher who is always active to the learners who are always passive. It is characterized by large class size which may range from 25-100. It is more suitable for high secondary 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.
- (iii) Students are responsible for making their own notes.
- (iv) It is teacher- centered; the teacher or the lecturer does the major activities, i.e. talking illustrating or presenting the films or other aids.

Though lecture method is generally considered to be a weak pedagogy, universities have not yet found practical alternative teaching methods for large majority of their courses (Adedoyin, 1990). The lecture method is also known to have merits, e.g. knowledge, factual information are carefully transmitted to allow students gain a good understanding of a subject; it is less expensive compared to the inquiry methods. The lecture method has several short comings which include the following;

- (i) Passive learning by the students which make them weak and disinterested.
- (ii) Immediate evaluation provision of what has been learnt may not be possible
- (iii) It is one way method of communication that does not involve significant students' participation

In this study the effectiveness of inquiry teaching method was on means scores of diploma students of Kano State Polytechnic was investigated.

Cooperative learning is another teaching method 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 attitudes toward 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 hands on experimental.

Other teaching methods 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 assist the educational process (Mohsen, 1998). Interactive multimedia combines computer hardware, software and peripheral equipment to provide a rich mixture of text, graphics, sound animation, full-motion video, data and other devices to effectively convey information to students.

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

2.5 Academic Performance in Chemistry.

Academic performance is defined as the measure of what a person has accomplished after exposure to educational programmed. In research conducted by Harry and Newcomb (1990) on the effect of inquiry method and the essential benefits of inquiry approach, he shows that students exposed to inquiry instructional method scores higher than those students whom were taught the same concept using subject matter approach.

Shymansky, Kyle and Alport (1983) presented a meta-analysis of the effect of these inquiry associated curricular on the students performance and found that the curricular enhanced students science achievement and processes inquiry –base instruction in the literature has closely related by associated with other teaching methods.

Recent science education standards in U.S. proposed that all students should learn about both scientific inquiry and learn science through inquiry (National council, 1996). However, while some previous researches had shown that an inquiry–base instruction method can improve student science-process skills concept learning and achievement. Research on explicit teaching, (traditional instruction) has also revealed that students achievement is improved for certain kinds of instructional objectives (Waxman, 1991). In the same vein (German, 1989) examined the effect of cooperative learning strategies in geology achievement and student’s attitude towards science in Washington State University physical science

coverage and the result indicated that there was improvement in both achievement and students attitude towards science.

This study investigated the relation between teaching methods and academic performance of the students and teaching method and attitude of the students among Diploma students of Kano State Polytechnic.

2.6 Chemistry Learning and Retention;

Permanent and meaningful learning is the target of our educational endeavor. Understanding and retention are the products of meaningful leaning 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 in to memory. Thus appropriate coding of incoming learning, or in coming information provides the index that may be consulted; so that retention takes place without elaborate search ability retains and consequently remembers what we have been experienced, or what we have in the memory (Oyedokun, 1998). There are several factors that influence retention.

According Blair and Simon (1998) anything that aid learning should improve retention while things that lead to confusion, or interference among learning materials decrease the speed and efficiency of learning and accelerates forgetting. Interference may exist in several forms such as retroactive inhibition, or emotional inhibition. Retroactive inhibition result, 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 1908).

According to Paul (1999) retention is base 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 1908) 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.

In this study effectiveness of inquiry and lecture method on retention ability of the students were investigated.

2.7 Science Laboratory Technology

Science laboratory technology is an educational program in Kano State Polytechnic designed to produce practical men and women to manage science laboratories. The course aimed at producing technician and technologies that are adequately equipped, mentally and technically sound to solve practical scientific problems of the society (within the scope of their training). One of the major courses of science laboratory technology is chemistry.

Science educators have believed that the laboratory is an important means of instruction in science. Since 9th century laboratory's activities were used in high schools chemistry (Fay, 1986). Laboratory instructions were essential because they provide training in observation, supplying details information and arousing the interest of the students in scientific field. In the second hand book of research in teaching, Tamir (1976) listed some of the objectives that may be achieved in science laboratory classes which include to:

- (l) provides skills for manipulative, inquiry, investigative, organizational and communicative.
- (v) developed Concepts formation; such as formation of hypothesis, theoretical models, taxonomy and categorizing.
- (vi) developed Cognitive abilities; such as critical thinking, problem solving and understanding the nature of science
- (vii) attitudes formation; such as curiosity, interest and risk taking e.t.c

Polytechnic has been described by many researchers; according to Kerka (1990) polytechnics are unique institutions of high learning where technological knowledge and skills are acquired for direct application to the solution of problems of the society. It was established under Decree 33 of (1979).

The major purpose of polytechnic education is to produce a middle class level man and woman empower with the skills to mind the nation's

economy (Bashir 2005). Mekeahia (1986) reported that these institutions are to engage in research for developing human and materials resources needed by the nations' industries and economy. In order to meet the above mention needs the in cooperation of courses such as science laboratory technology is obligatory. Laboratory technologies have contributed immensely to the national development in deferent fields of human endeavors, such as medical pathology, agriculture research institutes food processing companies, pharmaceutical industries quality control laboratories among others.

This study investigated the effects of inquiry teaching method on academic achievement and retention among ND II science laboratory technology students of Kano state polytechnic.

2.8 Gender and Academic Achievement in Science;

Many studies carried out on gender effect on academic achievement have led to number of conciliating conclusions, some find gender as a relevant fashion in academic achievement, others found that there is no difference exists between the sexes in this area (Bunkure,2007). Generally, there has been great participation of males in science course and careers.

At first the traditional view interprets male centered inclination to science as inherent characteristics; therefore in the past many believed that females were uninterested in science and therefore choose not to participated (Stipek, 1996). Many studies have shown that boys' attitudes

toward sciences were more significantly positive than that of girls, especially boys' interest in chemistry and earth science is greater than that of girls (Donald, 2000, Wise & Okey, 1983).

In Nigeria, Jegede (1981) shows that there is a significant deference in academic achievement between male and their female counterparts with boys achieving higher than girls. (Mekeache, 1981) was not incomplete agreement with Jegede's findings. He showed that the performances of students in co-educational schools were better than those in single sex schools, that is, all boys or all girls. (Mekeache, 1981 showed that girls had better scores in chemistry than boys in single sex school (all boys or all girls). Greenfield (1995) determined whether the gender difference has any effect on decision to enter science project topics. She examined science and engineering students and concluded that:

- (i) Female are more likely now than 20 years back participating in science.
- (ii) Females' representation in the physical science has increased over the years.
- (iii) Engagement of females in physical science projects, such as earth science and mathematics is still less than that of males.
- (iv) Females tend to avoid project in scientific inquiry and experimental research instate of this, they prepared library base research.

In her study of science achievement, (Greenfield, 1996) Concluded that; males are more interested in studying sciences than females.

Jeff (1995) questions the historical nature of females' difficulties in science stating that the historical, social and political context of women' experience challenge the belief that, females historically have had a difficult time in science. He explains that women are not historically uninterested in science, rather, many bio graphics of women from all eras revealed their interest in the field. Jiffy also explored the "weaker sex" argument that says women are more suited for domesticity and certain occupational opportunities, for that, they need not study sciences.

This study investigated the effect between genders on academic achievement in the teaching of some chemistry concepts among diploma students of science laboratory technology when exposed to inquiry teaching method and lecture method.

2.9 Attitudes towards Chemistry and Instructional Strategies.

Sola and Ojo (2007), define attitude as beliefs and opinions that can predispose individual to behave in certain ways. From the above definition attitude can be seen as to comprise of cognitive and affective components.

Attitudes are thought to influence future behaviors and have implications for such things learning as observed by Kay (1990), when he reported that both cognitive and affective attitudes were significant predictors of

commitment to the use of learning. Song-Ling and Chumyen (1999) 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 strategies on geology achievement and students attitudes towards science. He indicated that inquiry teaching method improved academic achievement and enhanced the students' attitudes towards sciences.

The present study intends to investigate among others the effect of inquiry teaching method on attitudes of the students towards chemistry instruction among diploma students of Science Laboratory Technology of Kano State Polytechnic.

2.10 An Overview of Similar Studies

Laboratory skills or science-process skills have shown to have some positive effect on the student's academic achievement. Students taught with inquiry-base teaching method show better academic performance then those taught with lecture method (Basega, 1994). Laboratory teaching assumes

firsthand experience in observation and manipulation of materials. Inquiry-based instructional method is associated with laboratory instruction which is often emphasizes the science process skills.

According to (Nation Research Council 1996) all students should learn about scientific inquiry. Adedoyin (1990) contended that most of scientific theory was based on a large number of very sophisticated experiments. He suggested that if lecture topics are theorized, this should be done through the use of audio-visual aids or demonstration. This critically illustrate the used of inquiry method and science laboratory teaching /instruction. This is based on the fact that several researches have shown that an inquiry-based instruction method improves students' science process skills, concepts learning and achievements (Flick, 1995) stated that research on inquiry-base instruction has produced well trained students, capable of handling tools and science skills.

According to Songlong (1998), inquiry-based instruction produces positive outcomes on student's concept learning, especially at higher cognitive levels of Blooms taxonomy of education. A modern technique of research is meta-analysis in which a group of studies is analyzed for similarities and differences in findings related to their common trust.

In meta-analysis studies on the effect of many teaching strategies as many as 12 strategies, laboratory method was found to be more effective

than all (Wise & Okey, 1983). (Harry & New comb, 1990) reported that inquiry approach has been widely accepted as the best for teaching vocational subject such as agriculture and technical courses. This suggested that subjects in sciences that require practical application should be taught using the inquiry teaching method approach.

Shymansky et al. (1983) reported that the strongest effect of the inquiry associated curricular is in biology and the weakest is in education. This strongly implies that the method inquiry method is the best for science laboratory technology. Tamir (1976) had earlier confirmed this statement; he showed that from the standpoint of view the activity of the students dominates the nature of their experience and the individualization of laboratory instruction should contribute positively to learning. He concluded that one would expect laboratory teaching method to have advantage over the other teaching methods in the amount of information retention ability, or in the actual skills in observation or manipulation of materials.

2.10.1 Implications of the Literatures Reviewed to the Present Study

In the paragraphs above, a lot of literatures have been reviewed leading to the insight about the topic being investigated the finding of these literature has some implication for the present study. For quite along time science teachers have been restless searching for effective instructional strategies

and fruitful curriculum materials that would collectively foster the teaching of science to the younger generation. The finding of most of those studies concluded that academic performance is enhanced by using effective instructional strategies which recognize active student's participation.

(Johnson & Johnson 1990) stated that cooperative learning experiences promotes positive attitudes towards the instructional experiences then competitive or individual methodologies. (shymansky,kyle & Alport1989) presented a meta-analysis of the effect of inquiry associated curriculum on the students performance and found that the curriculum enhanced students' science achievement and result in better academic performance. Donald (2000) conducted an experiment on the effect of traditional lecture method in teaching two sections of an undergraduate chemistry course on the retention he discovered that those students taught using inquiry method had better retention level then those taught with traditional lecture method.

Many studies have been reviewed on the effect of gender on academic achievement, some stated that there significant differences in academic achievement and attitudes among the sexes. However others found no differences exists in this area. (Stipek, 1996, Donald 2000, Paul 1999) stated that boys attitudes towards science were more significantly positive than that of girls especially boys interest in chemistry, physic and

earth science. (Mekeach 1981), Jeff 1995 and Bunkure 2008) see no relation between academic achievement and sex differences. The summary of the literature review show that instructional method which involves students' activities enhances better academic performance and better retention ability.

This study used two teaching methods one was inquiry method of instruction which is student-centered. It involved student's activities that will make learning of chemistry more meaningful and purposeful and so to enhance better students understanding. The other was traditional lecture method which was teachers- center. The effectiveness of the two teaching method were investigated and compare in relation to academic achievement retention and attitudes change

CHAPTER THREE

METHODOLOGY

3.1 Introduction

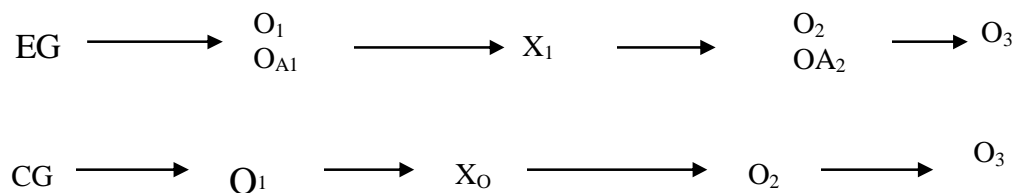
This study investigated the effects of inquiry on the academic performance, retention and attitudes towards chemistry, among diploma students of Kano State Polytechnic. In the previous chapter, literature related to the study was reviewed. This chapter examines the methodology employed in carrying out the study. The chapter focuses on the research design, population of the study, sample and sampling procedure. Specifically, the chapter is presented under the following subheadings:

- 3.1 Introduction
- 3.2 Research Design
- 3.3 Population of the Study
- 3.4 Samples and Sampling Procedure
- 3.5 Instrumentation
- 3.6 Data Collection Procedure
- 3.7 Data Analysis

3.2 Research Design

The design for this study is quasi experimental in nature. It is a pre test, post-test and post-posttest experimental group and control group design. The control and experimental groups were pre-tested to determine their group equivalence at the start of the experiment. Experimental group was

given an attitude pre-test this is to determine the attitude of experimental group towards chemistry before they were exposed to treatment. The control group was taught the same chemistry concept using traditional teaching strategy. The design is illustrated as follows;



Where;

EG = experimental group

CG = control group

O₁ = pre-test

O_{A1} = pre-test attitude

X_I = inquiry method

X_O = lecture method

O₂ = post test

O_{A2} = post test attitude

O₃ = post- posttest

This design is recommended by Fraenkle and Wallen, (2000) for a study of this nature

3.3 Population of the Study

The Population of the study consisted of all 206 NDII Science Laboratory Technology Students of Kano State Polytechnic, for 2008/2009 session. (See Table 3) This category of students had completed first year in the polytechnic and were stable and familiar with the school environment, laboratories and the instructors. The students are of average age of 22 years. Details of the population are given in Table 3.

Table 3.1 Diploma II, Science Laboratory Technology Enrolment, Kano State Polytechnic 2008/2009 session

group	Morning session	Afternoon session	Total
Male	45	51	96
Female	70	40	110
Total	115	91	206

Source: Office of the Head of Science Laboratory Technology Department, Kano State Polytechnic (2008)

3.4 Sample and Sampling Procedure

A sample of 70 Diploma II chemistry students was selected by random sampling. This technique was used because, according to Freankle Wallen (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

(70 students) was sufficiently large enough for an experimental study of this nature as it conformed to Fraenkle and Willen (2000) who reported that the recommended minimum numbers of subjects is 30 in each experimental and control group for an experimental study of this type. Two hundred and six 206 students were considered. The list was then divided in two substrata, boys and girls and then control and experimental groups respectively. The experimental group was from the morning session and the control group from the afternoon session. This was to avoid interaction of the two groups during administration of the treatment. In the experimental group there was 17 male and 18 female while in the control group there where 20 male and 15 female. The number of the samples in both experimental group and control group was 35 each; the groups were located at Kano State Polytechnic. Details of the samples are shown in Table 4.

Table 3.2 Sample Selected for the Study

Group	Number of Sample Selected		
	Male	Female	Total
Experimental group	17	18	35
Control group	20	15	35
Total	37	33	70

Source; Office of Head of Department 2009/2010

3.5 Instrumentation

The instruments used for data collection were Chemistry Achievement Test (CAT) and Chemistry Attitude Questionnaire (CAQ). The (CAT) was used in assigning the samples, pretest, posttest and post-posttest. The (CAT) was based on the concept of acid, base and salt concept. It consists of 20 multiple choice questions followed by five (5) options A—E students were asked to circle the correct option. Ten short answer questions were also given and the students were to provide correct answers to them. The chemistry attitude questionnaire (CAQ) was used for attitude testing before and after the treatment. The CAQ has two parts; part one seeks response on students personal data such as, name, sex and age. Part II consists of a 5-point Likert-scale responses (i.e. strongly agree, agree, undecided, disagree, strongly disagree) on Students' Attitude towards toward chemistry learning. The instruments used were constructed by the researcher. The Likert scale is scored 5 for strongly agree 4 for agree 3 for undecided, 2 for disagree and 1 for strongly disagree, for all positive statements. This was reversed, that is, 1, 2, 3, 4 and 5 respectively for strongly agree, through strongly disagree for negative statements. The details of instruments are given in Tables 4.4 and 4.5

Validation of CAT and CAQ

The CAT was derived from the curriculum of National Board for Technical Education and some past question papers of Diploma students.

The instruments were validated by psychologists, specialists in chemistry and science education, based on the following terms of reference:

- (a) to determine the appropriateness of the instruments with reference to the purpose of the study.
- (b) grammatical structure of the questions the clarity and the content area. All the corrections and suggestions pointed out were effected to enhance the validation of the instruments.

Reliability of Chemistry Achievement Test (CAT)

A pilot study was conducted to establish reliability of the instrument Twenty NDII Science Laboratory Technology Students of Abdullahi Adamu Federal Polytechnic, Kazaure, in Jigawa State were randomly selected for the pilot study. The test contains appropriate instructions on how to answer the questions (see Appendix i) the test was administered at first and second occasion within an interval of fourteen days under the same conditions as the first one. On each occasion of the test administration, it took the students 60 minutes to answer the questions. The scores of the students were recorded in term of their overall performance on the test and retest administered. The reliability coefficient of the test and re-test scores were computed by means of Pearson Product Moment Correlation Coefficient (PPMCC), for details of the calculation see Appendix 3.

This statistics was used to ascertain if there is any correlation between the first and second test of the study sample. The reliability coefficient r was found to be 0.78 (see Appendix 3, for details of the calculation)

3.6 Administration of Treatment

It is important to distinguish between inquiry and traditional instructional strategies used in his study. According to flowers (1987) inquiry – based teaching is emphasizing observation and interpretation of data. Inquiry based instruction in this current study similarly emphasizes hands-on-minds-on activities that involve gathering data and information critically to examine the data for relationship and interpret the data.

The experimental group which consists of 35 students which are from the morning session were subjected to six weeks teaching (each week 2hrs) using inquiry-based method using acid, base and salt concepts where all materials needed was provided to the students. These materials include different types of acids strong and weak acids and different types of bases and salts litmus paper and even an internet facility. All other materials that would make an inquiry method instruction a success were provided. During the lessons the students carried out different activities and investigation under the supervision of the teacher.

The most important characteristic of the lesson was that, the lesson was “students-centered”. Activities were designed to encourage students to

become more adapted to using science process skills and more knowledgeable about acid, base and salt concept.

The control group which consists of the same number of students as in the experimental group and which were in the afternoon session, were taught the same concept for the same period of time using the traditional lecture method. A number of variables were held constant so that statistical comparison between experiment and control group could be made. The constant variables were Diploma II science students, the same school environment, same participating teacher and same duration. The only variable that changed was the teaching method.

3.7 Data Collection Procedure

Two instruments were used for data collection namely Chemistry Achievement Test (CAT) and Chemistry Attitudes Questionnaire (CAQ). CAT was used as pre-test and post-test, and post post-test, While CAQ was only given to the experimental group as attitude pre test and attitude posttest.

3.7.1 Pre-test administration

Before the Administration of the treatment the subjects of the study that is the experimental group and the control group were subjected to pretest to determine the level of their performances for the purpose of comparison. The means scores of the two groups were calculated and subjected to a t-test statistic to determine group equivalence between experimental group and

control group at the start of the experiment refers to appendix I. the experimental group were then given a pre - attitude questionnaire to determine the attitude of the students before were expose to inquiry teaching method refers to appendix 8a. The two groups were then exposed to chemistry instruction on acid, base and salt concept for six weeks. The experimental group was taught using inquiry teaching method while the control group was taught using traditional lecture method.

3.7.2 Posttest Administration

At the end of six weeks, a posttest was administered to both control and experimental groups this was to determine the means scores of the two groups. The experimental group was also given an attitude post-test after the treatment to determine whether there was a change in attitude before and after the experiment.

Post-posttest

Two weeks later, a post-posttest was administered to both experimental and control groups to determine if there was any significant difference in the mean scores of the post test and post-post test. This according to Harry and Newcomb (1990), two weeks is enough to test retention level of the students.

3.5 Data Analysis

The data collected were analyzed using t-test statistic to answer the research question as well as test the null hypotheses.

H₀₁: There is no significant difference between the means scores of students taught chemistry concepts using inquiry methods and those taught the same concept using lecture method. This hypothesis was tested using t-test.

H₀₂: There is no significant difference between the means scores between male students taught chemistry concept using inquiry method of teaching and their female counterparts taught same concept using the same teaching strategy. This hypothesis was tested using t-test.

H₀₃: There is no significant difference in the retention of learned concepts between students taught chemistry concepts using inquiry method and those taught same concept using lecture method. A t-test statistics was used to test this hypothesis.

H₀₄: There is no significant change in students' attitude towards chemistry before and after exposed to inquiry teaching method. The data collected were analyzed by using weighted average to find the means of the scores before and after the treatment. The result was then subjected to t-test analysis to test the null hypothesis

CHAPTER FOUR

ANALYSIS, RESULTS AND DISCUSSION

4.1 Introduction

In this chapter, the results of the data analysis are presented. The results are presented below according to the sequence of the research question and hypothesis which guided the study. The research has four research questions.

4.2 Hypotheses Testing

The first hypothesis in this study is that;

H_{O1} : There is no significant difference between the mean scores of students taught chemistry concepts (acid, base and salt) using inquiry methods and those taught the same concept using traditional lecture method.

The post test data of the experimental and control groups were generated via CAT and were subjected to t-test statistical analysis to determine if there is any significant difference in academic achievement of students in the experimental and their counterparts in the control groups. Summary of the analysis is presented in Table 4.2

Table 4.1 t-test analysis of the Post Test Mean Scores of the Experimental Group (EG) and the Control Group (CG)

Groups	N	Mean	SD	DF	t- calculated	t-critical	Remark
Experimental	35	22.24	2.45	34	2.25	1.54	*Significant
Control	35	21.56	2.72				

***Significant (P =0.05)**

From Table 4.1 the calculated t-value is 2.25. This value is greater than the t-value critical which is 1.54 at 5% alpha level with $df = 34$. This means that there is a significant difference between the post test mean scores of the experimental and the control groups in favor of the experimental group. Thus the null hypothesis is rejected. This implies that the experimental group taught chemistry using inquiry method of instruction achieved significantly higher than the control group taught same concepts using lecture method. This had answered the first research question that is there is a significant difference in the mean scores of the students taught chemistry concepts using inquiry teaching method and those taught the same concept using lecture method.

4.3 Testing H_{O2}

H_{O2} : There is no significant difference in academic performance between male students taught acid, base and salt concepts using inquiry

method of teaching and their female counterparts taught same using the same teaching strategy.

To test this hypothesis, the post test achievement scores of the experimental and control group were split according to sex of the subjects in the group and compared accordingly. The mean scores of the male and female students who were exposed to the inquiry method of instructions were subjected to t-test statistical analysis. The results obtained are shown in Table 4.2

Table 4.2 t-test Analysis of post-test Mean Scores of Male and Female Students in the Experimental Groups

Groups	N	Means	SD	DF	T-Calculated	T-critical	Remark
Male students	17	22.29	2.44				*Not Significant
				34	0.21	1.645	
Female Students	18	22.18	2.45				

*Not Significant (P=0.05)

From Table 4.2, the calculated t-value is 0.21. This value is less than the value of t-critical which is 1.645 at 5% alpha level with df = 16. The null hypothesis is therefore retained. This means there is no significant difference between the mean scores of the male students and their female counterparts of the experimental group exposed to inquiry teaching method. This implies that both male and female students performed equally well

after exposure to Inquiry teaching method, and it is concluded that Inquiry teaching method is gender friendly. This also answered the second research question that is inquiry teaching method had no effect on the gender of the students.

4.4 Testing H_{03}

H_{03} : There is no significant difference in retention ability between students taught acid, base and salt concepts using inquiry method and those taught the same concept using lecture method.

The data analyzed to test this hypothesis were post-posttest achievement scores of the experimental group (EG1) and control group (CG). The mean scores were subjected to t-test statistical analysis. The results are shown in Table 4.3

Table 4.3 t-test analysis of the Post-post-Test Mean Scores of the Experimental Group (EG) and the Control Group (CG)

Groups	Mean	SD	DF	T-Calculated	T-Critical	Remark
Experimental	21.54	2.94				
			34	7.17	1.645	*Significant
Control	18.6	2.95				

*** Significant (P = 0.05)**

The result of Table 4.3 shows that the t-value calculated 7.17 is higher than the t-critical 1.645 at alpha level of 0.05 with df= 34. This means that there is a significant difference in post post-test result of the experimental group and control group in favor of the experimental group. Thus the hypothesis is

rejected. This shows that the experimental group taught using inquiry method of instruction retained the taught concepts better than those taught using traditional lecture method. This answered the third research question, that is inquiry teaching method result in greater retention of the learn concepts (acid, base and salt)

4.5 Testing H₀₄

H₀₄ There is no significant change in students' attitude towards chemistry before and after exposure to inquiry teaching method.

Two types of data were analysed to test this hypotheses, namely: student's responses to CAQ before commencement of the experiment Table 4.4 and students responses to CAQ after experiment Table 4.5. The essence was to investigate change in students' attitudes towards chemistry before and after the experiment

The data in Tables 4.4 and 4.5 show the trend of the responses by the sample. From Table 4.4 the total scores of 1171 was earned by 35 subjects working through 12 items. Thus, the mean attitude scores was $1171/35 \times 12 = 2.78$. A score of 2.78 signifies that the general attitude of the students were negative. In a Licket 5-point scale a mean score of 3.0 signifies the deciding point or score. Any mean score above 3.0 indicates a favorable or positive disposition, while any mean score below 3.0 signifies an unfavorable or negative disposition). It should be noted that item 12 of the instrument is a negative item.

In Table 4.5, where the post-experiment attitudes of the subjects are shown, total values of 1,162 points are shown. The attitudes mean score for this set would be $1622 \div (35 \times 12) = 3.86$.

The value of 3.86 indicates a positive (or improved) attitude. To test the difference between the two means a t-test was employed. The data are shown in Table 4.6. This answered research question there is significant change in attitudes of the experimental group after exposure to treatment

Table 4.4 Student's Attitude Towards Chemistry before Experiment

s/no	Questionnaire item	SA	A	U	D	SD	TOTAL
1	Inquiry teaching is the best way of learning chemistry	30	32	12	14	10	98
2	I prepare to learn chemistry through inquiry method of teaching	20	28	15	20	9	92
3	More courses should be taught by means of inquiry teaching method	20	24	30	12	9	95
4	Inquiry method provides better asses to scientific method then lecture method	20	52	18	12	6	108
5	The use of inquiry method provides and creates more interaction between students and the teachers.	15	32	18	20	8	93
6	The use of inquiry teaching method creates more interaction between students of chemistry	5	20	36	20	7	88
6							
7	The use of inquiry teaching method increases motivation for chemistry	0	56	24	10	8	98
8	The use of inquiry method makes chemistry more interesting	25	52	24	6	6	113
9	The use of inquiry method Encourage sense of responsibility and self discipline	25	44	18	18	4	109
10	The use of inquiry method helps students to learn more chemistry than other methods do	15	24	21	12	13	85
11	The use of inquiry teaching method helps provides better learning experience.	5	28	9	22	13	79
12	The use of inquiry teaching method make heavy demand on the	4	12	24	40	35	115
	Total	104	404	249	206	121	1171

Table 4.5 Student's Attitude Towards Chemistry after Experiment.

s/no	Questionnaire item	SA	A	U	D	SD	TOTAL
1	Inquiry teaching is the best way of learning chemistry	85	44	0	6	4	139
2	I prepare to learn chemistry through inquiry method of teaching	55	52	0	16	3	126
3	More courses should be taught by means of inquiry teaching method	35	60	24	2	4	125
4	Inquiry method provides better asses to scientific method then lecture method	105	24	18	2	1	150
5	The use of inquiry method provides and creates more interaction between students and the teachers.	60	76	0	8	0	144
6	The use of inquiry teaching method creates more interaction between students of chemistry	70	60	0	12	0	142
7	The use of inquiry teaching method increases motivation for chemistry	80	44	0	16	0	140
8	The use of inquiry method makes chemistry more interesting	120	0	0	22	0	142
9	The use of inquiry method Encourage sense of responsibility and self discipline	35	100	9	0	0	144
10	The use of inquiry method helps students to learn more chemistry than other methods do	120	4	27	0	1	152
11	The use of inquiry teaching method helps provides better learning experience.	80	56	3	0	4	143
12	The use of inquiry teaching method make heavy demand on the	150	20	15	0	25	75
	Total	860	540	96	84	42	1622

Table 4.6 t-test Analysis of Attitudes Mean Score of Experimental Group before and after Experiment.

Groups	N	Mean	SD	DF	t- calculated	t-critical	Remark
Before the exp.	35	2.78	2.6				
				34	5.45	2.54	*Signifi Cant
After the exp.	35	3.86	3.75				

***Significant (P =0.05)**

From the data generated on Table 4.6 this shows that, there is a significant change in attitudes of the experimental group before and after exposure to the inquiry teaching method. T-value calculated 5.45 is higher than t-critical of 2.54 at alpha level of 0.05 with df=34. Thus the null hypothesis is rejected.

4.6 Summary of Findings

- (i) Analysis of data to test H_{01} shows that there is a significant difference in the mean scores of the experimental group and control group in favor of the experimental group which implies that the inquiry teaching method was more effective instructional strategy than the traditional lecture method.

- (ii) Analysis of data used to test H_{02} indicates that the performance of male and female students is the same when exposed to inquiry teaching method in Chemistry, which means that inquiry teaching method is gender friendly.
- (iii) Analysis of post-posttest, data used to test H_{03} indicates that the retention level of students taught using inquiry method of instruction is higher than that of students taught using lecture method
- (iv) Analysis of data to test the H_{04} shows that students developed positive attitude toward chemistry after exposure to inquiry method of instruction via the CAT.

4.7 Discussion of Results

After six weeks of the inquiry-oriented instruction, the experimental group had significantly higher means scores in chemistry achievement test than did the control group. It may be that pupils exposed to the treatment had the opportunity to observe, record, and interpret data on their own during hands on investigative activities.

From the analysis of data it is empirically confirmed that inquiry method of instruction significantly improved students' performance. This finding is in line with that of Campbell (1966), who reported that practical exploration and experimentation leads to a constant interplay between students and teachers, which leads to effective learning. Similarly Basaga (1994) observed that the lecture method would be declared obsolete and relegated like all old models to a resting place in a science museum.

This finding is also in line with the report by Copper and Copple (1985) and Batey, (1986) where inquiry method of instruction was reported to aid better performance than the other conventional methods of instruction among students. Other facts that emerged from the data were that; the method encourages interaction between teachers and students on one hand and between students and students on the other. This observation is a reflection of Eze (1991) who observed the teacher should train the students to recognize problems, since individual thinking, though not easy, should be encouraged because it fostered interaction and that the science class becomes alive as students get involved and pursue answers to their own problems.

Another significant finding of this study is that female students performed equally well as their male counterparts when both were exposed to the inquiry method of instruction. This is contrary to the report by Donald (2000), Wise and Okey (1985), who reported that boys' performances in sciences, is greater than that of girls. The finding also contradicted Jegede (1981), where it was reported that boys' achievement in science is higher than that of the girls.

However, the finding is line with Bichi (2002) who reported that there was no significant difference in academic achievement between male subject and female subject taught using problems solving and those using lecture method. Afemike (1982) recorded no significant difference between males and females in their science achievement. The inquiry method of teaching is gender friendly.

Also the study discovered that students taught by inquiry teaching method retain the learnt concept more than those taught using lecture method. The results showed that the experimental group had a post-post test means score of 21.54, while the control group had a means scores 18.6. The statistically significant difference between the two means suggests that inquiry method of teaching led to effective learning out come then the traditional lecture method this finding is in agreement with Bichi (2002) how compare the effectiveness of problems solving strategy and that of traditional lecture method on students of retention of the concept and found that problem solving teaching strategy enabled the subject to have effective learning and higher retention level then the traditional lecture method.

Another important finding of this study is that; inquiry teaching method has positive effect on the attitude of the students. In this two types of data were analyzed to test a null hypothesis, namely:-

i) Student's response to (CAQ) before commencement of experiment, Table 4.4 and their response to (CAQ) after the experiment Table 4.5. The essence was to investigate change in students' attitude towards inquiry teaching method before and after the treatment.

Before the experiment, the data in table 4.4 was analysed and it has the total score of 1171 and weighted average of 2.78. This shows the general attitude of the students was negative. In table 4.5, where the post-experiment attitudes scores of the subjects are shown a total value of 1,162

points are shown, the attitudes mean score for this sets would be $1622 \div (35 \times 12) = 3.86$. The value of 3.86 indicates a positive (or improved) attitude. This means that the null hypotheses four (H_{04}) is rejected. There is a significant change in attitudes of the experimental group towards chemistry after being exposure to the treatment.

This agrees with the findings of German (1989), who reported that IMT leads to more positive students' attitude than the use of conventional traditional lecture method. It is also in line with that of (Wise & Okey 1989), reported inquiry teaching method helps students to develop more positive attitude and aids higher academic achievement than traditional lecture method.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter focused on the summary of the research findings, conclusions implications of the study and recommendations. The Chapter is presented under the following subheadins

5.1 Introduction

5.2 Summary

5.3 Summary of the Findings

5.4 Conclusions

5.5 Recommendations

5.6 Limitations of the Study

5.7 Suggestion for Further Studies

5.2 Summary

In this study the effectiveness of inquiry teaching method on academic achievement and retention of acid, base and salt concepts among Diploma 11 students of Kano State polytechnic were investigated and compared this with similar achievement that can be attained in traditional lecture method. It also investigated the effects of gender related differences on students' academic achievement in the teaching of chemistry concepts using inquiry teaching method.

The study tested four hypotheses and answered four research questions. It was conducted in school of technology Kano State Polytechnic.

Available literature relevant to study was reviewed. Most of those literature concluded that academic performance can be enhanced using effective instructional strategies which recognized active participation of the students. (Shymansky, Kyle & Alpprt 1989) presented a meta-analysis of the effect of inquiry teaching method associated with curriculum on the performance and found that the curriculum enhanced students' science achievement and result in better academic performance. (Johnson 1990) stated that inquiry teaching method promote positive attitudes towards instructional experiences than the traditional lecture method.

The design of the study was quasi experimental in nature. It was pre test, posttest and pos-posttest control group and experimental group design. The population of the study consists of 206 Diploma II science laboratory technology students' students of Kano State Polytechnic 2008/2009 session. A sample of 70 students was selected to serve as sample of study by random sampling from the mention above population.

Two instruments were used for data collection, namely:

- i. Chemistry Achievement Test (CAT) and chemistry attitudes questionnaire.

The CAT consist of 20 items multiple choice and 10 short answered based on acid, base and salt concept, with reliability coefficient of 0.785.

Chemistry achievement test instruments (ACT) with reliability coefficient of 0.785.

- ii. Chemistry attitudes questionnaires which consists of 12 items and 5-points Likert scale responses (i.e strongly agree, undecided, disagree and strongly disagree). The experimental group was pre tested on attitude before experiment and post tested after the experiment. The data collected via CAT was subjected t-test statistical analysis. It was found that Hypothesis one, three and four were rejected while hypothesis two was retained. Questionnaire was also constructed and administered to the experimental group before and after the experiment the data collected was analysed using weighted average and it was found that there is positive change of attitude of experimental group towards chemistry after the experiment.

5.3 Major Findings

This study investigated the effect of inquiry teaching method on student's academic achievement

- (i) Analysis of data to test H_{O1} shows that there is a statistical significant difference in the mean scores of the experimental group and control group in favor the experimental group which implies that inquiry teaching method was more effective instructional strategy than traditional lecture method.

- (ii) Analysis of data used to test H_{02} indicates that the performance of male and female students is the same when exposed to inquiry teaching in Chemistry, which means that there is no statistical significant differences mean scores of male and female students exposed to inquiry teaching method.
- (iii) Analysis of post-posttest, data used to test H_{03} indicates that the retention level of students taught using inquiry method of instruction is higher than that of students taught using lecture method. There statistically significant differences in the mean scores of experimental group compared to that of the control group.
- (iv) Analysis of data to test the H_{04} shows that there is a statistical significant differences in the attitudes of experimental group before and after exposure to inquiry teaching method student had developed positive attitudes toward chemistry after exposure to inquiry method of instruction via the CAT.

5.4 Conclusions

From the finding of this study, the following conclusions were drawn:-

- A. Instructional strategies that teachers use in the teaching of science have significant effects on the students' achievement.
- B. Inquiry teaching method facilitates effective learning of acid, base and salt.

- C Students that were taught chemistry concept using inquiry teaching method retained the learned concepts better than those taught using traditional lecture method.
- D Neither male nor female students performed better than other when taught chemistry concept using inquiry teaching method.

5.5 Recommendations

On the basis of finding emanated from this study, the following recommendations are made:

- 1 The teaching of chemistry should be conducted in such a way that students effectively learn and retain the concepts presented to them. The use of inquiry method seems to be appropriate in that respect. It should, therefore be incorporated into the main stream of pedagogy in the teaching of chemistry in polytechnic and colleges of higher education.
- 2 The use of traditional lecture method of teaching has been found to be less effective in this study, with respect academic performance and retention, in the learning of chemistry concept (acid base and salt) for that inquiry method of teaching should be encouraged and lecture method should be used with caution.
- 3 Equal opportunity should be given to both male and female in the choice of the subject of study.

- 4 In-service training programs for science teachers in form of seminars, workshops and conferences should focus more on how to use inquiry method of instructional strategies in the teaching of chemistry concept

5.6 Limitations of the Study

This study has the following limitations:

- 1 The study was limited to ND II Chemistry Students of Kano State Polytechnic and this narrow the scope of generalization of the study.
- 2 Only 70 science students were involved in the study. It may be possible that if larger number of subjects was used the result might not be the same.
- 2 Both experimental and control groups were in the same institution but attending school at different time, this may lead to some leakage of information during the administration of the treatment

5.7 Suggestions for Further Study

This study can further be extended in the following ways:

- (i) By conducting similar study, which will focus on the teaching of other science subjects should be carried out using inquiry method instruction with the view to find out whether similar or different result could be obtained.
- (ii) By extending the study to other tertiary institutions in to see if the use of inquiry method of instruction will yield better learning out come.

REFERENCES

- Adedoyin, F.A. (1990) Teaching Strategies in Population Education: Perspective in Population Education Selected Reading in Population Education 2, *National Education and Deveopment Council (N.E.D C) Lagos, N.E.R.D.C pressl.*
- Afemike, O.A. (1982) Evaluation of Chemistry Teaching in Benin city. *Journal of science teacher s of Nigeria (SATN) 20 (2).*
- Agboola, O.S. and Oloyede, E.O. (2007), Effect of Project, Inquiry and Lecture – Demonstration Teaching Method on Academic Achievement on Senior Secondary Student in Separation of Mixtures practical test. *Educational research and Review 2(6):124-132*
- Basaga, H., Geban, O., and Tekkaya C. (1994) the Effect of Inquiry Teaching Method on Biochemistry and Science Education Process Skills achievement. *Biochemistry education, 22, 29-32*
- Bashir A. (2005), *The Role Science Laboratory Technicians and Technologist in the Educational System of Nigeria.* A paper presented at a conference by National Association of Science Lobaratory Students week, at School of Technology Kano State Polytechnic 30th Nov.2005
- Batey, A. (1986). Building a case for computers in chemistry classrooms. Paper presented at 2nd leadership in computer education seminar seattle.
- Bunkure, Y.I. (2007) *Effect of Computer Assisted Instruction on Student Academic Achievement in Physics Among NCE II Student in Kano State.* Unpublished Msc. (Ed) thesis Department of Science Education A.B.U. Zaria
- Bichi S.S. (2002) *Effects of Problem Solving Strategy and Enriched Curriculum on Students Achievements in Evolution Concepts Among Secondary School Students,* A Ph.D thesis unpublished A.B.U Zaria.
- Blair G.M. Jones, R.S. and Simon, R.H.(1908) *Educational psychology* London, the Macmillan company
- Bradderman, T (1985) Laboratory Programs for Elementary School Science: A Meta-analysis of Effects on Learning. *Science Education 69:577-591*

- Callahan JF, Clark LH, and Kellough RD. *Teaching in the Middle and Secondary Schools* (5th ed.). Englewood Cliffs, NJ: Prentice-Hall, 1995.
- Cheval & Hart 2005) *the Effect of Achieve Learning on Student Characteristics in Human Psychology*.
- Carol, A. (1988) High School Graduate in entry level Jobs: *What do Employers want?* (*Eric Digest No. 40*). New York reproduction service No. ED 293972.
- Copper,j. and cople, C. (1985). *Computer in Educational Research Review and Instruction Implications* Washington DC. Center for Research is to practice.
- Donald A.B. (2000) *What is the Use of Lecture?* San Francisco: Jossey –Bass ISBN 0-7879-5162-5
- Eze, A.E. (1991). *Special Method of Teaching Physics* in C.S Udenya and O.S Okobiah (Eds). *Special Methods of Teaching Science Subject (79-89)*. ABIC. Enugu and Lagos, Nigeria. Of Nigeria Unpublished Phd thesis University of Wales, Wales.
- Flick L. B. (1995) *Complex Instruction in Complex Classrooms a Synthesis of Research on Inquiry Teaching Method and Explicit Teaching Strategies*. Paper presented at Annual Meeting of the National Association for Research in Science Teaching Sanfrancisco CA.
- Fraenkle, J.R. and Wallen, N.E. (2000) *How to Design and Evaluate Research in Education (3rd Edition)* McGraw Hill, New York, Pp22-46
- Flowers J.L. (1987), *Effect of the Problem Solving Approach on Achievement, Retention and Attitudes of Vocational Agricultural Student in Illinois*. (Doctoral dissertation, University of Illinois at Urbana Champaign, 1986). *Dissertation abstracts international* 47:3285A.
- Greenfield, T.A. (1995) An Exploration of Gender Participation Patterns in Science Teaching *Journal of Research in Science Teaching* 32 (7) 737-748
- German P.J. (1989) Directed –Inquiry Approach to Learning Science Process Skills: Treatment Effect and Aptitude –Treatment Infection. *Journal of Research in Science Teaching* 26:237-250.

- Haussler, p. and Hoffman, L. 2002. An Intervention Study to Enhance girls Interest, of Self-concept and Achievement Physics class. *Journal of Research in Science Teaching*. 39 (9), 870-888
- Harry, N.J. and L.H., Newcomb (1990) Effect of Approach to Teaching on Students Achievement, Retention and attitude, *Journal of Agricultural Education* 16:9-13
- Ibrahim A. (2006). *The Role of Laboratory in the Teaching of Teaching Chemistry in Nigeria* Paper Present at Kano State Polytechnic.
- Jeffe, D.B. (1995) About Girl's Difficulty in Sciences: a Social not Personal matter. *Teachers' College Record* 97 (2) 200-226.
- Jegede, O.J. (1981) An Evaluation of the Integrated Science Project, Unpublished PhD thesis A.B.U Zaria
- Johnson, D.W and Johnson R.T. (1990) *Social Skills for Successful group work Educational Leadership* 42 (4): 29-33
- Kyle, W.C. Bonnstetter, R.J. and Gadsden, T. Jr. (1983) An Implementation: an Analysis of Elementary Students and Teaching Attitude Towards Science in Process Approach Vs. Traditional Science class. *Journal of Research in Science Teaching* 25: 103-120
- Kerka, S. (1990) *Job Related Skills (Ewc digest No. 94)* Columbus, Ohio; Eric Document production
- Kay, R. H. (1990). Predicting Student Teacher Commitment to the use of Computers, *Journal of Educational Computing Research*, 6, 299-309. Service No. ED 318912.
- Muhammad Z. (2007) *Effect of Inquiry Teaching on Academic Achievement of Biology Class Unpublished P.G.D.E. Thesis F.C.E. Kano*
- Mattheis, F. E (1988). *Effect of a Laboratory Centered Inquiry program on Laboratory Skills, Science Process Skills and Understanding in Middle Grades Students.* (ERIC Document).

- Mohsen, (1998) Gender Differences in General Academic Self-esteem and in Success Expectation on Delmet Academic Problems *Journal of Education Psychology* 83 (5)
- Mckechie, W.A.J (1986) *Teaching Tips: A Guide Book for the Beginning College Teacher* Lexington. M.A D.C Health and Company
- Najjar, L.J. (1996) Multimedia Information and Learning, *Journal of Educational Multimedia and Hyper media*, 5,129-150
- National Research Council (1986) *National science education standards* Washington, D.C.National Academic press
- National Research Council (1989) *Every Body Counts a Report to the Nation on Future of Mathematics Education* Washington, D.C. National Academy press.
- Oyedukun, C.A (1998) *Effect a Conceptual Change Model on Student Achievement, Retention and Attitude to Biology Concept* Unpublished Phd *thesis*_Ahmadu Bello University, Zaria
- Olatoye, R.A. and Afuwape M.O. (2004) Students' Integrated Science Academic Achievement as a Predictor of the later Achievement in Biology Chemistry and Physics *Journal of the Science Teachers association of Nigeria* (1 and 2): 10-15
- Paul, H.K. (1999) the Relationship between Active Learning and Long Term Retention, Introductory Statistics course *International statistics institute 52nd session*
- Rossini B.A. AND Jim, F. (1997), the Effect of Cooperative Learning Methods, on Achievement, Retention and Attitude of some Home Economic Students in the North Caroline *Journal of vocational and Teaching Education* 13(2) 1-12
- Shehu A.G. (1996) *An Introduction to Curriculum Process*, Tammaza Publication Company limited Zaria.
- Sola, A.S. and Ojo, E. (2007), effect of project, inquiry and lecture – Demonstration Teaching Method on Academic Achievement on senior Secondary Student in Separation of Mixtures Practice test. *Educational research and review*2 (6): 124-132.

- Song –Ling,M., Chun-yen, C. and James, P.B. (1998) Inquiry Teaching and its Effects to Secondary School Students' Learning of Earth Science Concepts.
Journal of Geoscience Education 46:363-36
- Stipek, D. (1996) *Motivation and Instruction in D.C. Berliner and R.C. Calfee (Edi) Hand Book of Educational Psychology*, Macmillan New York pp 85-116
- Shymansky J.A. Kyle, W.C. and Alport, J.M. (1983) The Effect of New Science Curricula on the Student Performance. *Journal of research in science teaching* 20: 387-404 Soreson flower 1987
- Tamir, P. (1976) *the Role of the Laboratory in Science Teaching Tech Rep., No. 10* Iowa City, Iowa the University of Iowa Science Education Centre. UNESCO, *Group Techniques in Education Science Teaching Schools of Trofical Africa (1963)*.
- West African Examination Council, Statistics Division Lagos (1994-1999) Result of Candidates at the Senior School Certificate Examinations (SSCE) May/June in Biology, Chemistry, Physics. Senior School Certificate Examination (SSCE) May/June in Biology, Chemistry and Physics
- Wikipedia (2009) Free Encyclopedia Wikipedia Available on at <http://.....>
- Waxman H.C. (1991) Productive Teaching and Instruction, Assessing the Knowledge Based in: H.C.wax and H.J. Walbieg (Eds) *Effective Teaching Current Research*, Berkeley; Mc Cutchen Pub. Co. pp 33-61
- Wise O. and Okey Y.(1983). A Meta – Analysis of the Effect of Various Science Teachers on Achievement. *Journal Research in Science Teaching* 20 (5)
- Weisstein, E W (2007) Wivison Singned Rank test Retrieved on 21/05/2007 from <http://math.woud.watran.com/wilcosinged.rank.test.htm>
- Y.C. Wong, C.T. wong, L.E. Akpanisi and S.O.Oyiruka (2002) *University General Chemistry*. African feb publishers LTD

APPENDIX 1

CALCULATION OF RELIABILITY OF CHEMISTRY ACHIEVEMENT TEST (CAT)

AFTER TEST AND RE-TEST ADMINISTRATION USING PPMCC STATISTIC

S/NO OF STUDENTS	TEST SCORES		X ²	Y ²	XY
	TEST (X)	RE-TEST (Y)			
1	60	65	3,600	4225	3900
2	70	65	4,900	4,225	4,550
3	30	40	900	1,600	1,200
4	50	60	2500	3600	3000
5	65	70	4,225	4,900	4,550
6	50	55	2,500	3,025	2,750
7	35	45	1225	2025	1575
8	30	40	900	1,600	1,200
9	60	60	3,600	3,600	3,600
10	60	60	3,600	3,600	3,600
11	45	55	2025	3025	2475
12	50	50	2,500	2,500	2,500
13	45	45	2,025	2,025	2,025

14	70	70	4,900	4,900	4,900
15	60	70	3600	4900	4200
16	60	55	3,600	3,025	3,300
17	60	60	3,600	3,600	3,600
18	45	50	2,025	2,500	2,250
19	60	65	3,600	4,225	3,900
20	30	45	900	2,025	1,350
21	50	55	2,500	3,025	2,750
22	60	65	3,600	4,225	3,900
23	30	35	900	1,225	1,050
24	50	45	2,500	2,025	2,250
25	55	65	3025	4225	3575
TOTAL	1280	1390	1638400	1932100	1779200

$$r = \frac{N\sum xy - \sum x \sum y}{\sqrt{[\sum x^2 - (\sum x)^2] [N\sum y^2 - (\sum y)^2]}}$$

Where r = coefficient of reliability

N = No. of students.

$$\frac{25 \times 1779200 - 1280 \times 1390}{\sqrt{(16398400 - (1390)^2 \times 25) (1932100 - (1932100))}}$$

$$r = \frac{25 \times 1779200 - 1280 \times 1390}{\sqrt{(16398400 - (1390)^2 \times 25) (1932100 - (1932100))}}$$

$$r = 0.785$$

Appendix 2

Table of specification showing the relation in the number questions given to the content areas and instructional objectives in an academic test given to NDII science Laboratory Technology Students of Kano State Polytechnic

Content areas	Instructional Objectives				Total
	%	Knowledge level	Comprehensions Level	Application level	
Acid	43.33	05	04	04	13
Base	30.00	04	02	03	09
Salt	26.60	03	03	02	08
	100%	12	09	09	Total = 30

Appendix 3

Chemistry Achievement Test (CAT) Base on the Concept of Acid Base and Salt

Instruction: There are two sections in this test (section I and II)

SECTION I contains multiple-choice questions and **section II** contains short answers questions. You are required to fill in the blanks spaces provided in section I

MALE

FEMALE

SECTION A

- According to the Arrhenius theory an acid is any substance which:
 - React with water to form salt
 - React with salt to form base
 - Dissociates in water to produce hydrogen ions H^{+1}
 - Dissociate in water to produce hydroxyl in OH
- Strong Acid
 - React fast
 - Dissociate completely
 - Dissociate partially
 - Has no water in it
- A pure concentrated sulphuric acid is non electrolyte, because;
 - it contains hydroxlye ion OH^{-1}
 - it contains no ion at all
 - it contains hydrogen H^{+1}
 - its ions are not free to move.
 - it is corrosive
- Write equation to show how $Cl_3C\ COOH$ behaves as an arrhenius acid:
 - $Cl_3CCOOH + H_2O \rightleftharpoons Cl_3\ CCOO + H_3O^{+}$
 - $Cl_3\ CCOOH + \rightleftharpoons Cl_3CCOO + H_3O^{+}$
 - $CH_3\ CCOOH + H_2O \rightleftharpoons Cl_3CCOOH_2^{+} + HO$
 - $Cl_3CCOH + H_2O \rightleftharpoons Cl_3CCOO + H^{+}$
- According to Bronsd – Lowry concept, an acid is a
 - Proton acceptor
 - Proton donor

- c. Electron pair donor
 - d. Electron acceptor
 - e. non of the above
6. According to Brønsted – Lowry concept NH_3
- a. Is an acid
 - b. Is a base
 - c. Is a salt
 - d. Non of the above
7. What is the conjugate base of this acid CN^-
- a. CN^-
 - b. HCN
 - c. NOH_3
 - d. CNO
 - e. CN^-
8. Which of 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 electron pair donor while a base is an electron pair acceptor
 - c. An acid is proton donor while a base is a proton acceptor
 - d. An acid react with a base to form salt and water.
 - e. an acid reacts with a base only at high temperature.
9. Which of the following can be classified as Lewis acid:
- a. H_2O_4
 - b. NH_3
 - c. OH^-
 - d. H^+
10. Which of the following acids is strongest than all:
- a. H_2SO_4
 - b. H_2SO_3
 - c. HCl
 - d. H_3O^+
 - e. HNO_3 .
- II. Sour milk contains
- a. Micocondra acid
 - b. Citric acid

- c. Lactic acid
 d. tartaric acid
 e. Ascorbic acid
12. The PH of lemon juice is likely to be;
 a. 1.0 b. 3.0 c. 5.0 d. 7.0 e. 13
13. to dilute 100cm³ of 5M solution of sulphuric acid solution to 2M you add
 a. 250cm³ of distilled water
 b. 500cm³ of distilled of distilled water
 c. 200cm³ distilled water
 d. 100cm³ of distilled water
 e. 1000cm³ of distilled water
14. Consider the following about acids
 I. strength ii concentration iii basicity
 Which of the following statement is correct?
 a. all these refer to the same thing
 b. they refer to quite different thing
 c. (i) and (ii) are refer the same things
 d. (i) and (iii) are the same but ii is different
 e. (ii) and (iii) are the same but I is different
15. A standard solution is defines as;
 (a) a normal solution of acid
 (b) a molar solution of an acid
 (c) a solution whose concentration is unknown
 (d) a solution of known concentration in moldm⁻³
 (e) an acid solution only
16. what volume of 0.1m nitric acid contains 31.5g of pure nitric acid [H=1,N=14,O=16]
 (a) 5dm⁻³ (b) 10dm⁻³ (c) 0.2dm⁻³ (d) 2,0dm⁻³ (e) 3.5dm⁻³
17. the basicity of tetraoxosulphate (iv) acid is
 (a) 7 (b) 4 (c) 5 (d) 3 (e) 2
18. neutralization reaction always produces;-
 (a) salt and water only (b) acid and salt only (c) acid and base only
 (d) water only (e) acid base and salt only
19. which of the PH value indicates a basic solution
 (a) 1 (b) 0 (c) 3 (d) 7 (e) 9

- 20 which of the following acid can be called a dibasic acid
(a) hydrofluoric acid (b) hydrochloric acid (c) trioxonitrate (v) acid
(d) ethanoic acid (e) hydrogen tetraoxo sulphate (vi) acid

SECTION B (SHORT ANSWER ITEM)

21. Defined Bronsted-Lowry concept of acid.....
.....
22. Write Henderson Hesselbalch equation
.....
23. A given that a solution has a $[H^+]$ as $3.2 \times 10^{-5} \text{mol dm}^{-3}$ what is $[OH^-]$ of the solution?.....
.....
- 24 Define pH
- 25 Define a buffer solution
- 26 Define an alkali
- 27 name a suitable indicator for titration of hydrochloric acid against aqueous ammonia
.....
.....
28. Give a general method of preparation of salt
29. Give one example of acid salt
- 30 Show the relation between pK_a , pK_b , and pK_w

Appendix 4
MARKING SCHEME OF CAT

SECTION A

1. According to the Arrhenius theory an acid is any substance which:
 - c. Dissociates in water to produce hydrogen ions H^+
2. Strong Acid
 - b. Dissociate completely
3. Pure dry ethanolic and a solution of hydrogen chloride or ethanoic acid in organic solvents are non-electrolytes because:
 - d. Their ions are not free to move.
4. Write equation to show how $Cl_3C COOH$ behaves as an arrhenius acid:
 - a. $Cl_3CCOOH + H_2O \rightleftharpoons Cl_3 CCOO^- + H_3O^+$
5. According to Bronsted – Lowry an acid is a
 - b. Proton donor
6. According to Bransted – Lowry NH_3
 - b. Is a base
7. What is the conjugate acid of this base CN^-
 - b. HCN
8. Which of these statements is correct about acids and base according to Lewis concept?
 - a. An acid is an electron pair acceptor while base is an electron pair donor.
9. Which of the following can be classified as Lewis acid:
 - c. OH^-
10. Which of the following acids is strongest than all:
 - d. H_3O^+
- II. Sour milk contains
 - c. Lactic acid
12. The PH of lemon juice is likely to be;
 - b. 3.0
13. to dilute $100cm^3$ of 5M solution of sulphuric acid solution to 2M you add
 - a. $250cm^3$ of distilled water
14. Consider the following about acids
 - I. strength ii concentration iii basicityWhich of the following statement is correct?

- b they refer to quite different thing
- 15 A standard solution is defines as;
(d) a solution of known concentration in mol dm^{-3}
- 16 what volume of 0.1m nitric acid contains 31.5g of pure nitric acid [H=1,N=14,O=16]
(e) 3.5dm^{-3}
- 17 the basicity of tetraoxosulphate (iv) acid is (e) 2
- 18 neutralization reaction always produces;-
(a) Salt and water only
- 19 which of the PH value indicates a basic solution
(e) 9
- 20 which of the following acid can be called a dibasic acid
(e) hydrogen tetraoxosulphate (vi) acid

SECTION B (SHORT ANSWER ITEM)

21. Give an example of a complex
 $\text{K}_3[\text{Fe}(\text{CN})_6]$ any suitable example could be taken
22. Write Henderson Hesselbalch equation
 $\text{PH} = \text{PKa} + \log [\text{conjugate}]/[\text{acid}] \dots\dots\dots$
 $\dots\dots\dots$
23. A given that a solution has a $[\text{H}^+]$ as $3.2 \times 10^{-5} \text{mol dm}^{-3}$ what is $[\text{OH}^-]$ of the solution?
 $3.125 * 10^{-10}$
- 24 Define pH
 $\text{PH} = - \log [\text{H}^+]$
- 25 Define a buffer solution ...
A buffer solution is a solution of a week acid and its conjugate base
- 26 Define an alkali
An alkali is soluble of hydroxide
- 27 name a suitable indicator for titration of hydrochloric acid against aqueous ammonia
Methyl indicator $\dots\dots\dots$
28. Give a general method of preparation of salt

By neutralization

29. Give one example of acid salt



- 30 Show the relation between $\text{p}K_a$, $\text{p}K_b$, and $\text{p}K_w$

$$\text{p}K_w = \text{p}K_a + \text{p}K_b \dots\dots\dots$$

APPENDIX 5

Schedule of Teaching the Groups by Week, Day and Hour

Week	Day	Hours	Group	Treatment
1	Friday	10-12 am	experimental group	I .M
	Saturday	10-12 am	control group	L.M
2	Friday	10-12 am	experimental group	I .M
	Saturday	10-12 am	control group	L.M
3	Friday	10-12 am	experimental group	I .M
	Saturday	10-12 am	control group	L.M
4	Friday	10-12 am	experimental group	I .M
	Saturday	10-12 am	control group	L.M
5	Friday	10-12 am	experimental group	I .M
	Saturday	10-12 am	control group	L.M
6	Friday	10-12 am	experimental group	I .M
	Saturday	10-12 am	control group	L.M

Note:

LM = Lecture Method

I.M = inquiry method Instruction

APPENDIX 6

Chemistry Attitude Questionnaire (CAQ) Preamble

The information required in this questionnaire is for research purpose only and will be treated with utmost confidentiality therefore answer the questions as fully and truthfully as possible. The questionnaire is divided into two parts:

Part 1 Students personal data

Name (Optional): _____

Student No.: _____

Sex: _____

Age: _____

Part II Students Attitude towards Chemistry learning

Read each statement and then tick (✓) the best option that shows how you feel.

SD = Strongly Disagree, D = Disagree, U = Undecided A = Agree

SA = Strongly Disagree.

CAQ

S/N	STATEMENT ON ATTITUDE	STUDENT RESPONSES				
		SD	D	U	A	SA
1	Inquiry teaching method is the best way of learning chemistry					
2	I prepare to learn chemistry through inquiry method of teaching					
3	More courses should be taught by means of inquiry teaching method					
4	Inquiry method provides better asses to scientific method then lecture method					
5	The use of inquiry method provides and creates more interaction between students and the teachers.					
6	The use of inquiry teaching method creates more interaction between students of chemistry					
7	The use of inquiry teaching method increases motivation for chemistry					
8	The use of inquiry method makes chemistry more interesting					
9	The use of inquiry method Encourage sense of responsibility and self discipline					
10	The use of inquiry method helps students to learn more chemistry than other methods do					
11	The use of inquiry teaching method helps provides better learning experience.					
12	The use of inquiry teaching method make heavy demand on the teacher					

APPENDIX 7

Students Respondents to (CAQ) before Exposure to IMT

SD=1, D=2, U=3, A=4, SA=5

S/No	Questionnaire Item and Respondents Scores											
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
1	2	3	2	3	3	5	2	4	3	5	3	3
2	3	3	3	3	3	3	3	3	3	3	3	3
3	2	2	3	3	3	3	2	2	4	3	1	3
4	3	3	3	3	3	3	3	3	3	3	3	3
5	4	3	4	4	2	4	3	2	5	5	3	4
6	1	2	4	4	3	1	1	5	4	4	2	1
7	3	3	3	4	4	4	3	3	3	4	3	3
8	4	1	4	3	2	4	4	3	4	1	4	3
9	2	2	5	4	3	3	4		2	1	2	4
10	2	3	2	2	1	2	3	3	2	2	3	2
11	4	4	1	5	2	1	4	3	4	4	1	5
12	5	1	1	4	4	4	1	5	5	1	1	3
13	5	4	1	2	2	1	3	3	1	4	4	2
14	4	5	4	1	1	2	1	3	5	1	1	5
15	2	3	1	3	4	3	3	3	3	2	1	4
16	2	1	2	2	5	4	2	5	5	3	4	2
17	1	1	3	4	4	2	1	4	4	2	1	5
18	1	2	3	4	3	2	4	3	2	1	2	1
19	5	4	1	4	4	3	4	1	2	4	4	3
20	1	4	3	5	4	2	2	2	1	2	5	4
21	5	5	1	4	4	3	4	1	2	5	4	4
22	4	5	1	1	5	1	4	5	4	5	1	1
23	4	2	4	4	1	3	3	1	2	2	1	2
24	3	5	4	1	1	2	1	3	4	1	1	4

25	1	2	2	5	4	3	4	2	2	1	2	1
26	5	4	5	3	2	3	4	5	3	4	2	1
27	1	1	3	4	3	3	2	4	5	3	1	2
28	1	2	3	2	1	2	4	4	3	3	2	2
29	4	3	5	5	2	4	4	2	3	3	2	3
30	3	2	1	4	2	1	3	3	2	1	1	2
31	1	2	3	3	1	3	2	4	4	1	2	2
32	2	2	3	3	2	2	4	3	1	3	2	1
33	3	3	1	4	2	1	3	3	4	7	1	3
34	3	4	3	1	1	2	1	3	3	1	3	2
35	2	4	3	1	1	2	1	3	4	1	1	3

APPENDIX 8

Students Respondents to (CAQ) after Exposure to IMI

S/No	Questionnaire Item and Respondents Scores											
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
1	4	1	5	4	4	5	4	4	5	5	4	5
2	4	2	4	5	5	4	2	1	4	5	4	3
3	5	4	4	4	4	5	4	4	4	3	4	5
4	5	5	3	5	5	4	5	4	4	5	5	3
5	5	4	5	4	4	5	4	4	5	5	4	5
6	4	4	4	5	5	5	5	1	4	3	5	5
7	4	2	3	4	4	4	4	4	4	5	4	3
8	1	5	4	5	5	4	5	1	4	5	5	5
9	5	2	5	5	5	4	5	1	4	5	5	5
10	4	2	4	4	4	5	4	4	4	5	4	3
11	1	5	3	5	5	4	5	4	4	5	1	5
12	1	4	4	3	4	5	4	4	3	3	4	5
13	4	4	4	4	4	5	5	5	2	2	3	3
14	5	5	4	3	4	5	4	4	4	3	4	5
15	5	4	3	5	4	4	5	1	4	5	5	4
16	5	4	5	3	4	5	4	4	5	5	4	5
17	4	4	4	5	5	4	5	4	4	5	5	5
18	4	2	1	3	4	5	4	4	3	5	4	4
19	5	2	4	5	5	4	2	1	4	3	5	5
20	4	5	3	5	5	4	2	1	4	3	5	5
21	5	2	5	2	4	5	5	4	4	4	5	4
22	5	4	3	1	4	5	5	4	3	5	4	1
23	4	4	4	5	2	4	2	4	4	3	5	5
24	5	5	4	5	2	2	2	4	4	3	4	1
25	5	4	1	5	2	2	2	4	5	5	1	1
26	5	5	4	5	2	2	2	4	5	1	1	1
27	2	5	2	5	4	2	2	4	5	5	5	1

28	5	1	1	5	4	2	5	4	4	5	1	4
29	5	1	4	5	4	2	5	4	4	5	5	4
30	5	5	3	4	4	4	4	4	4	3	4	3
31	4	4	4	5	5	5	5	1	4	5	5	5
32	4	2	1	3	4	5	4	4	3	5	4	4
33	5	4	3	5	4	4	5	1	4	5	5	4
34	2	5	5	5	5	4	5	1	4	5	5	4
35	4	4	4	5	5	5		5	5	3	3	3

APPENDIX 9**CHEMISTRY ACHIEVEMENTS TEST SCORES OF EXPERIMENTAL GROUP
(E.G) AFTER EXPOSURE TO C.A.I.**

STUDENTS No	GENDER	SECTION I (25)	SECTION (10)	TOTAL
01	FEMALE	14	8	25
02	FEMALE	13	7	20
03	FEMALE	25	9	34
04	FEMALE	19	8	27
05	FEMALE	20	7	27
06	FEMALE	14	8	22
07	FEMALE	18	8	26
08	FEMALE	15	9	24
09	FEMALE	13	6	19
10	FEMALE	17	8	25
11	FEMALE	21	8	29
12	FEMALE	21	7	28
13	FEMALE	16	7	23
14	FEMALE	20	5	25
15	FEMALE	23	8	31
16	MALE	19	7	26
17	MALE	20	8	28
18	MALE	18	7	25
19	MALE	18	8	26
20	MALE	23	7	30
21	MALE	23	8	31
22	MALE	22	6	28
23	MALE	18	7	25
24	MALE	19	5	24
25	MALE	16	6	22
26	MALE	12	6	18
27	MALE	17	8	25

28	MALE	20	8	28
29	MALE	20	7	27
30	MALE	14	7	21
31	MALE	21	8	29
32	MALE	12	8	20
33	MALE	21	6	27
34	MALE	17	7	24
35	MALE	17	8	25
	TOTAL			891

APPENDIX 10
CHEMISTRY ACHIEVEMENTS TEST SCORES OF CONTROL GROUP (C.G)
AFTER EXPOSURE TO LECTURE METHOD

STUDENTS No	SECTION I (25)	SECTION (10)	TOTAL	
01	FEMALE	14	8	22
02	FEMALE	20	7	27
03	FEMALE	10	5	15
04	FEMALE	19	5	24
05	FEMALE	13	6	19
06	FEMALE	18	7	25
07	FEMALE	17	7	24
08	FEMALE	12	5	17
09	FEMALE	12	6	18
10	FEMALE	13	6	19
11	FEMALE	17	8	25
12	FEMALE	12	7	19
13	FEMALE	13	6	19
14	FEMALE	18	6	24
15	FEMALE	20	8	28
16	MALE	9	6	15
17	MALE	14	6	20
18	MALE	17	5	22
19	MALE	12	5	17
20	MALE	16	6	23
21	MALE	14	8	23
22	MALE	21	8	29
23	MALE	10	5	15
24	MALE	11	6	17
25	MALE	12	6	18
26	MALE	17	7	24
27	MALE	16	7	23
28	MALE	12	8	20
29	MALE	18	7	25

30	MALE	17	8	25
31	MALE	16	5	21
32	MALE	15	6	21
33	MALE	17	5	23
34	MALE	13	7	20
35	MALE			28
	TOTAL			754
