EFFECT OF TEACHING-WITH-ANALOGY ON ATTITUDE, RETENTION AND PERFORMANCE IN CHEMISTRY AMONG SECONDARY SCHOOL STUDENTS IN ZARIA METROPOLIS, KADUNA STATE, NIGERIA

BY

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B.Sc (Ed) Chemistry A.B.U. 2011
P13EDSC8056

A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY ZARIA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER DEGREE IN SCIENCE EDUCATION

DEPARTMENT OF SCIENCE EDUCATION,
AHMADU BELLO UNIVERSITY,
ZARIA

MARCH, 2018

DECLARATION

I hereby declare that this dissertation entitled "Effects of Teaching-With-Analogy on Attitude, Retention and Performance in Chemistry, among Secondary School Students in Zaria Metropolis, Kaduna State, Nigeria" 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 and sources of information are fully acknowledged by means of references.

_____ _____

Aminatu Imam, MUHAMMAD **Date**

CERTIFICATION

This dissertation entitled “Effects of Teaching-With-Analogy on Attitude, Retention and Performance in Chemistry among Secondary School Students in Zaria Metropolis Kaduna State Nigeria ” by Aminatu Imam MUHAMMAD with Reg. No. P13EDSC8156 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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DEDICATION

This work is dedicated to my parents Malam Imam Muhammad Saeed, my Mum Hajiya Hassana Abubakar Imam, my husband Mudaththir Adam and my children Jameela, Muhammad Saleem, Nana Fatimah for their love, concern, moral and financial supports.

ACKNOWLEDGEMENTS

Thanks are due to Almighty Allah, the Creator and Sustainer of the Universe, the Gracious the Merciful, who made it possible for me to carry out this study.I wish to appreciate most sincerely Dr. S.B. Olorukooba my major supervisor for her guidance, objective, constructive criticism, suggestions and cooperation without which this work could never have been completed. Your love, patience and words of encouragement are highly appreciated. I also wish to express my sincere gratitude to Dr. T.E. Lawal my second supervisor for her advice. Your contributions and encouragement are highly appreciated.

I am also grateful to Prof. (Alhaji) Isa Usman for his contributions and moral support. I appreciate my lecturers Prof. A.A. M. Shaibu, Prof. S.S. Bichi, Dr. S.S. Obeka, Dr.M.R Bawa, Dr. F.K Lawal, Prof. M.M Atadoga, Prof. M.A Lakpini and Prof. M. Musa for your words of encouragement, advice, moral support which added quality to the work.

I also want to extend my gratitude to Zaria Educational Inspectorate Division, principals, staff and students that participate in this study and to all my colleagues in Science Education Department Ahmadu Bello University Zaria for their contribution and cooperation during the course of this study.

Finally, I am most grateful and indebted to my beloved and wonderful husband Adam Mudaththir whose love, motivation and financial support saw me through this work. My thanks go to all my beloved children Jamila, Muhammad Saleem, and Nana Fatimah. I appreciate you all.

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ABBREVIATIONS USED

ABPT: Acid Base Performance Test

CAQ: Chemistry Attitude Questionnaire

NCE: Nigeria Certificate in Education

NECO: National Examination Council

SSSCE: Senior Secondary School Certificate Examination

STAN: Science Teachers Association of Nigeria

TWA: Teaching With Analogy

OPERATIONAL DEFINITION OF TERMS

The following terms are operationally defined as used in the context of the study

Academic Performance: It refers to a student's success in meeting short- or long-term goals in education.

Teaching-With-Analogy: It is a strategy that serves like a bridge linking the gap between the prior knowledge of students and the new concepts to be learnt by introduction of something familiar to explain unfamiliar science concept.

Lecture Method: Is a teaching method in which one person, usually the teacher, presents a spoken discourse on a particular subject. It is characterized by one way flow of information from the teacher to the learner in which the teacher does all the talking and the students do all the listening.

Attitude: It refers to ones feelings, thought and predisposition to behave or respond to in some particular manner. An attitude denotes interest or feelings towards studying.

Retention: It is the ability of the learner to remember tasks, information or knowledge gained after learning.

Metropolis: It is the chief or captal city of a region (Zaria and its environs).

ABSTRACT

The study investigated the Effects of Teaching-With-Analogy on Attitude, Retention, and Performance in Chemistry among Secondary School Students in Zaria Metropolis, Kaduna State Nigeria. The study employed a pretest, posttest and post posttest quasi experimental and control groups design. A total of one hundred and ninety two (192) students form the sample of the study out of the total population of 1611. Two instruments, namely Acid Base Performance Test (ABPT) and Chemistry Attitude Questionnaire (CAQ) were used for data collection. The ABPT was developed by the researcher from WAEC and NECO and validated by experts in Chemistry Education and Science Education Department. The reliability coefficient of ABPT was found to be 0.86 using Pearson Product Moment Correlation Coefficient Statistics, and CAQ was found to be r=0.76 using Spearman Rank Order Correlation. Four research questions were answered and four null hypotheses were tested. t-test statistics and Mann-withney U-test were used to determine significant difference of the two groups at level of significance $p \leq 0.05$. The major findings from the study include the following: there is significant difference in the mean performance scores of experimental and control groups in favor of experimental group. There is a significant difference in the retention ability of the students taught using analogy compared to those taught using lecture method of instruction in favour of experimental group. On the issue of gender, there is no significant difference between the performance mean scores of male and female students taught chemistry concepts using teaching-with-analogy. Based on the findings it was concluded that secondary school chemistry students learn acids bases and salts concepts better, developed positive attitudes toward chemistry and retained concepts taught better when taught using TWA.. The study recommends, among others, that chemistry teachers should be encouraged to use Teaching-With-Analogy in the teaching of chemistry.

CHAPTER ONE

THE PROBLEM

1.1 Introduction

Science as a concept is a process that is geared toward problem solving in order to enhance the living standard of man. Science can be regarded as a dynamic and objective process of seeking knowledge which involves scientist in the process of searching, investigating and seeking verification of natural things occurring in the environment (Nworgu, 2007). Nwagbo (2011) defined science as an intellectual activity carried out by human and designed to discuss information about the natural world in which he lives as well as to discover the ways in which the information can be organized to benefit human race. It can also be seen in terms of method and process as well as products comprising facts, concepts, principles and laws that make up the body of science. From these views students learning science are placed in problem solving situation. Owolabi, (2012) views science as an integral part of human society. Its impact is felt in every way of human life so much that it is intricately linked with a nation's development. There are four basic branches of science in secondary school curriculum: these are Physics, Chemistry, Biology, and Mathematics.

Chemistry as one of the branches of science deals with the nature of matter, its properties and its change in different conditions. Tajudeen (2009) defined chemistry as the science that deals with structure and composition of matter. For the purpose of this study, chemistry is defined as a subject that deals with the composition, properties and uses of matter. It probes into the principle governing the changes that matter undergoes. Chemistry according to Omoniyi (2014) should be studied to improve man's knowledge and enhance the understanding of the environment for survival. According to Ezeliora (2010) the power of chemical science creates as a whole an enabling infrastructure that delivers food,

medicine and materials which are the hallmarks of modern life. For instance, the knowledge acquired in chemistry provides theoretical bases for the synthesis of drugs which are used in medicine, manufacture of paints, cosmetics, shoes, textiles, plastics, soap and detergents. Aniodoh (2007) observed that the importance of chemistry can be felt in almost all sphere of our national life. Therefore, chemistry education has a fundamental role to play in providing solution to several technological and socio economic issues confronting man as well as improve scientific literacy (Ezeliora, 2010).

Many research findings such as that of Ajaja (2009), Gilbert (2009), Ahmed (2010) on the teaching of chemistry in Nigeria has revealed that, chemistry as a science subject is poorly taught because of the use of inappropriate method of teaching (Johnson, 2008). In spite of the importance of chemistry in our national development and the effort being made by government researchers, Science Teachers Association of Nigeria and other agencies, students' performance has been very poor and unsatisfactory year after year. Majority of the students perceived chemistry as a body of isolated fact to be memorized, lacking relevance to reality which has led to lack of interest in it by students. For many students, chemistry is a class room affair. The wrong perception of chemistry by students has resulted in low admission of students into chemistry and science related courses (Ezeliora, 2010). However, studies such as that of Njoku (2011) and the West African Examination Council Chief Examiners Report (WAEC, 2015) revealed that, academic performance of students in chemistry at Senior Secondary Certificate Examination (SSCE) has been very low. This general low performance of students is shown in Table 1.1

Many factors have been suggested as contributing to this low academic performance of students particularly in chemistry and science in general. Some of these factors include; poor teaching methods, inadequate facilities, and inadequate laboratory infrastructure for teaching chemistry (Tami, 2014). Results of several researchers

conducted over the years had indicated that of all the various factors responsible for low performance in chemistry, poor teaching method was the most predominate (Mari, 2014). One of the problems in implementing science curriculum has been the use of inadequate approach or instructional strategy for the teaching of chemistry concepts. A lot of emphasis has been placed on this by the experimental science curriculum projects at both international and local levels. But despite the amount of effort and emphasis, science teachers in Nigeria schools still revert to the use of lecture method for teaching, which has been the traditional approach of instruction rather than interactive and investigative approaches (Ifeakor, 2006).

The lecture method is characterized by one way flow of information from the teacher to the learners in which the teacher is the authority and almighty. He/she has all the science knowledge; he/she is the dispenser of science facts and information. He/she does all the talking and the learners do all the listening. The science teacher sees his students as empty vessels waiting to have science knowledge poured in to them. According to Bichi (2002), traditional science classroom is always dead silence with only the teacher talking, writing or dictating notes. The class has no surprises, no discoveries, no activities and no brainstorming (Bichi 2002). However, the method enriched with appropriate instructional strategies such as demonstration, guided-inquiry, discursion, teaching-with-analogy among others could enable the students process information with a view to solving problems which will however help them retain, improve their academic performance, as well as inculcate positive attitude towards the subject. There is therefore the need for further research into teaching methods or strategies that would improve attitude, retention and academic performance of the students.

Analogy is the comparison of something unfamiliar with something familiar in order to explain a shared principle. Ruhi, (2003) describes analogy as comparison of

something unfamiliar with something familiar in order to explain a shared principle, like a bridge that spans the gap between what a teacher wants the students to learn and what the learner already knows. Glynn, cited in Nworgu, (2007) noted that analogy can be regarded as comparison between something that is familiar to students (base) and an unfamiliar thing in science in which teachers want the students to acquire. Analogy builds on the framework of the learners existing knowledge so that learners are not starting from the scratch. In teaching with analogies, the goal is to transfer ideas from a familiar concept (the analogue) to an unfamiliar one (the target). Analogy may play a significant role in problem solving, decision making, creativity, explanation and communication. Nworgu, (2007) observed that the use of analogy has been found to be very effective in teaching students, because it aids motivation and visualization of difficult concepts.

In all cases of using analogy in science instructions, the aim has remained the same: To help learners understand (build knowledge of) new concepts presented in the class by calling up knowledge (memory) of concepts they have already mastered or become familiar with. The new concepts to be mastered are referred to either as 'target or unfamiliar concepts' while the concepts they are already familiar with are referred to as 'base or analog concepts'. It does not really matter from what field of knowledge or experience the analog concept are from. Both concepts –base and target are said to be analogous because they share some common features or characteristics. Hence the process of using analogous concepts in teaching and learning situation as a strategy is referred to as "Teaching-With-Analogy (TWA)".

In a simple diagrammatic sketch, the basic idea behind Teaching-With-Analogy (TWA) can be presented as:

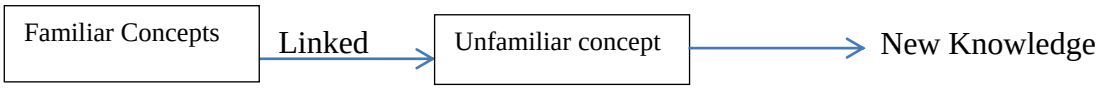

Fig 1.1: **Basic Idea Behind Teaching-With-Analogy**
Source: Researcher

The diagram illustrates the movement of knowledge from a familiar concept via the pathway of analogy to meet a new concept so that new knowledge, accommodated by the old is acquired.

When using analogy to teach science, Glynn (2007) identified the following steps to be followed in Teaching -With- Analogy (TWA):

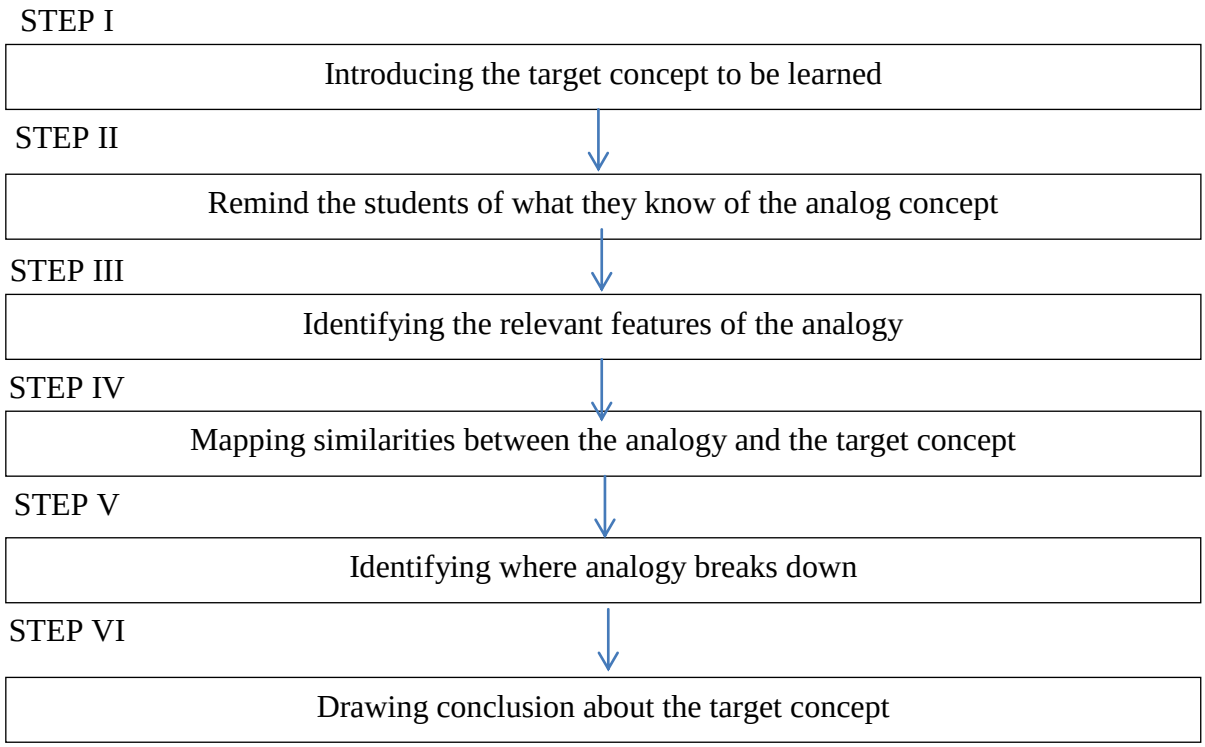

Fig 1.2: **A Flowchart of Teaching-With-Analogy Strategy**
Source: Glynn Model (2007)

However, the use of analogy could create an acceptable students understanding and at the same time generate misconceptions causing more confused learning. Therefore, for the use of analogies to be effective, teachers needs to prepare these analogies in detail and make sure there are connections between the analogies and the target they represent

(Kipnis, 2005). Hence, this study intends to investigate the effects of Teaching-With-Analogy on academic performance, retention ability and attitude of students towards chemistry.

Retention in this study is the ability of the learner to remember tasks, or material learnt concepts. Bichi (2002) defined retention as the ability to retain and recall information or knowledge gained after learning. Akinbola and Folashade (2007) argued that when teaching is characterized by rote learning and meaningless memorization, students make ineffective learning, and the fact thus learned are not long retained, nor do they seem to have much effect in changing behavior. Other researchers such as Mangal (2010) and Obeka (2010) investigated and defined several variables that affect retention. Some of which include; the content or task to be performed, learners past experiences, the interval between lesson and evaluation, and instructional strategies employed. Sulaiman (2007) reported that learning is an indicator of later performance, and that learning and retention therefore, should be considered together. It is therefore important to understand how acquired knowledge and skills are retained and should be maintained in the longer term. Hence, for retention to be effective individual must see a meaning or purpose for the information and teaching-with-analogy strategy provide the opportunity for students to see the meaning and establish a link for concepts learned. When learning is made meaningful, concepts are better organized and retention is improved. Hence this study posed to find if Teaching-With-Analogy has effect on retention of concepts learned.

One of the most and long regarded important outcomes of science teaching is the students' attitude toward science. Attitude is one of the most important and frequently researched issues /factors of science teaching. Ibraheem (2008) defined attitude as a learned disposition to respond in a consistently favourable or unfavourable manner with respect to a given object; while Erdemir and Bakirci (2009) described attitude as the

tendency for individual to organize thought, emotions, and behaviors towards psychological objects. Human beings are not born with attitudes they learn afterwards. Some attitudes are based on experience, knowledge, and skills, while some are gained from other sources. Adesoji (2008) revealed that a person's attitude is learned as opposed to being inherited. Such attitudes can be influenced by factors like the nature of the subject, the instructional strategy, among others. Also the use of inappropriate teaching method as opined by Dana (2006) leads to decline in students' attitude towards science. However, Adesoji (2008) reported that there is a relationship between attitude and methods of instruction. So also between attitude and achievement, and that it is possible to predict performance from attitude scores. Hence this study intends to use Teaching-With-Analogy to see if the students' attitude, retention and academic performance can be improved.

Gender refers to socially constructed rules, behaviours, activities and attributes that a given society considers appropriate for men and women. According to Bichi, 2002, it is the amount of masculinity and feminity found in human beings, the normal man has preponderance masculinity and normal female has preponderance of feminity. In recent years several researches had been conducted on gender related issues. Such as that of Duniya (2009), who noted that gender issues in science education as it affects performance remains unresolved. Usman (2010) noted that boys are more mechanically and scientifically inclined than girls. However, Danmole and Femi-Adeoye (2004) in their separate studies found that there were no gender differences in performance in science. Hence, one of the areas covered in this study was to find out if Teaching-With-Analogy is gender related.

1.1.1 Theoretical Framework

The theoretical basis that is guiding the study on the use of analogy to teach concepts of evolution is the constructivism theory of learning. The theory of constructivism is generally attributed to Bruner (1960) and Piaget (1980) who articulated that knowledge is internalized by learners through the processes of accommodation and assimilation. This implies that when individuals assimilate, they incorporate the new experience into an already existing framework without changing that framework. Ideally, analogy can help students to build meaningful relations between what they already know and what they are setting out to learn. In general, this activity of building relations plays a critical role in constructivist views of learning science, thereby involving students in the construction of knowledge and the creation of new ideas from what they already know (Ruhi,2003). This activity of building relation between existing knowledge and new knowledge plays an important role when interpreting students' learning as a process of conceptual change (Duniya, 2006). These theoretical speculations about the role of analogy in evolving conceptual change set the stage for empirical explorations of the contribution of analogy to conceptual change in science learning (Wushishi, 2006). According to Harrison (2001), constructivism is the process in which learners compare new information with old, within the context of their current conceptual framework and so reconstruct their knowledge. Ogunkunle and Gbamanja (2006) view constructivism as a process where learners actively take knowledge connect it to previously assimilated knowledge and make it theirs by constructing their own interpretation. Constructivism is an innovation and interactive instructional theory which incorporate other desirable teaching strategies, such as cooperative learning, guided-inquiry, problem solving and use of analogy among others (Sani, 2006).Based on this relevance, the research was designed to investigate the effects of Teaching-With-Analogy

on attitude, retention and performance in chemistry among secondary school students in Zaria Metropolis, Kaduna State Nigeria.

1.2 Statement of the Problem

Despite the importance of chemistry which can be felt in almost all spheres of our daily lives, performance of students has persistently been low in Senior Secondary Certificate Examination (SSCE). This general poor performance of students is shown in Table 1.1

Table 1.1 Performance of Students in Chemistry at WAEC (2008-2015) in Kaduna State

Year	No. of Students registered	No. of students Pass level (1-6)	% Pass	No. of students Fail level (7-9)	% Fail
2008	357658	178274	50.94	179384	49.06
2009	389462	170670	44.90	218792	55.10
2010	432230	194284	45.96	237946	54.04
2011	428513	185949	44.44	242564	55.56
2012	478235	204725	43.69	273510	56.31
2013	477573	236059	50.69	241514	49.31
2014	575757	280250	49.54	295507	50.46
2015	641622	270570	43.13	371052	46.87

Source; WAEC Chief Examiners' Report (2008-2015)
E_7 & E_8 are regarded as fail

Many factors have been suggested as contributing to this low academic performance of students particularly in chemistry and science in general, some of these factors include; poor teaching methods, inadequate facilities, inadequate laboratory infrastructures for teaching chemistry, and students attitude (Tami, 2014; Liza,2010).

Another reason identified by scholars is the students' perception of some chemistry concepts as complex and difficult, such concepts include: chemical equilibrium, stoichiometry, acids, bases and salts, redox reaction, electrolysis, among others (Olorundare, 2012). However, Ajaja,(2009) and Nworgu (2007) suggested the need to adopt a new strategy involving students acquiring positive attitude as well as enhancing

their academic performance, and retention that deviate in the style of teaching from the lecture method to active learning techniques. Hence, this study investigated the effects of Teaching-With-Analogy on attitude, retention and academic performance in chemistry among senior secondary school students, Zaria Metropolis, Kaduna.

1.3 Objectives of the Study

The objectives of the study were to:

i. determine the effects of Teaching-With-Analogy on academic performance in chemistry concepts among secondary school students,

ii. find out if Teaching-With-Analogy has effects on gender difference in chemistry concepts,

iii. determine the effects of Teaching-With-Analogy on retention ability of students in chemistry concepts, and

iv. find out whether teaching-with-analogy has any effects on students attitude towards chemistry .

1.4 Research Questions

The following research questions guided the study:

i. What is the difference between the performance means scores of students taught chemistry concepts using Teaching-With-Analogy and those taught using lecture method?

ii. What is the difference between the performance mean scores of male and female students taught chemistry concepts using Teaching-With-Analogy strategy?

iii. What is the effect of Teaching-With-Analogy on retention ability of students in chemistry concept?

iv. What is the effect of teaching-with-analogy on the attitude of students towards chemistry?

1.5 Null Hypotheses

The following formulated null hypotheses were tested at $p \leq 0.05$ levels of significance;

i. There is no significant difference between the performance mean scores of chemistry students taught chemistry concepts using Teaching-With-Analogy and those taught using lecture method.

ii. There is no significant difference between the performance mean scores of male and female chemistry students taught chemistry concepts using Teaching-With-Analogy.

iii. There is no significant difference between the retention ability of students taught chemistry concepts using Teaching-With-Analogy and those taught using lecture method.

iv. There is no significant difference in the attitude of students towards chemistry between those taught using Teaching-With-Analogy and those taught using lecture method.

1.6 Significance of the Study

The findings of this study would hopefully have significant impact in the following ways:

Researchers: The findings of the study would provide empirical evidence for further research in the area of this study (i.e. Teaching-With-Analogy).

Students: It would hopefully encourage active participation of the students, during teaching process.

Teachers: It would be beneficial to chemistry teachers on how to develop appropriate analogies to suit the students level of understanding in teaching difficult concepts of in chemistry to students.

Curriculum Planners: Curriculum planners who decide on syllabus might wish to consider the results of this study with the view to providing empirical basis for the inclusion of Teaching-With-Analogy instruction to improve students attitude, retention as well as improve academic performance in chemistry among secondary school students.

Professional bodies: It would benefit professional bodies such as Science Teachers Association of Nigeria (STAN) to organize conference and workshops for practicing teachers of chemistry to incooperate into their activities such effective teaching learning strategies in order to promote right attitude and retention ability of students as well as enhance their academic performance in schools.

Textbook Publishers: The findings would benefit textbook publishers in selecting, designing and writing of topicsin chemistry to be taught based on Teaching-With-Analogy Strategy.

1.7 Scope of the Study

The study was delimited to senior secondary school in Zaria Metropolis. All the schools involved in the study were government owned schools, because of their uniformity in socio-economic background, admission, promotion, policy and availability of teaching materials. SSII students was used for the study due to the fact that SSI students were newly introduced into chemistry, and SSIII students were preparing to write their SSCE. The concept selected for this study was Acids, Bases and Salts concepts. This was because, the Acid, Base and Salts concepts are among of the concept students have difficulties in learning and understanding (Anthony 2009).

1.8 Basic Assumptions

The study had the following basic assumptions:

i. The sample SSII students are taught by qualified chemistry teachers.

ii. All the schools were adequately equipped for effective teaching of chemistry concepts.

iii. The sampled students under study had not been exposed to Teaching-With-Analogy strategy before.

CHAPTER TWO

REVIEW OF RELATED LITERATURES

2.1 Introduction

This chapter reviewed literature related to the topic, "effects of Teaching-With-Analogy on attitude, retention and performance in chemistry among secondary school students Zaria metropolis, Kaduna state, Nigeria". Specifically, the areas reviewed are presented in the following sub-headings;

2.2 Nature of Chemistry and its Teaching in Secondary School Level

2.2.1 Teaching of Acid-Base and Salt Concept in Chemistry

2.3 Constructivism and Analogy in Science Teaching

2.4 Instructional Strategies in the Teaching of Chemistry

2.4.1 Lecture Method of Instruction.

2.4.2 Analogy as a Teaching Strategy in Science

2.4.3 Analogies in Acid-Base and salts Concepts

2.5 Students' Retention and Academic Performance in Chemistry

2.6 Students Attitude and Academic Performance in Chemistry

2.7 Gender and Academic Performance in Chemistry

2.8 Overview of Similar Studies

2.9 Implications of Literature Review for the Present Study

2.2 Nature and the Teaching of Chemistry at Secondary School Level

Chemistry has been defined as a subject that deals with the composition, properties and uses of matter. Chemistry is a very fundamental subject that is used in investigating the basic properties of substances in the physical universe. Fashola (2008) views chemistry as the science of materials in the natural and built environment and that it is pivotal to the development in the natural world. It is one of the means by which humans describe reality.

Gilbert (2009) observed that understanding chemistry requires understanding: the nature of chemistry, its norms, values and methods, the key theories, concepts and models of chemistry, how chemistry and chemistry based technologies relate to each other, and appreciating the impact of chemistry and chemistry related technologies on society. However, over the years, chemistry as well as all other fields of science has developed through series of discoveries. Scientist (such as Alchemist, Sir Dalton, Rutherford and so forth) make these discoveries with the use of their senses to observe what is happening around them. They put forward a reasonable explanation or hypothesis and carry out appropriate experiments to test the result of their experiments (Ababio, 2013).

The study of chemistry at the secondary school level helps students in developing basic skills, knowledge and competence required for problem solving in their environment. According to Ohodo (2005) chemistry contributes generally to the attainment of the aims of education and specifically helps individuals to develop effective process skills, critical thinking and competences required for dealing with observation, classification, measurement, counting numbers, recording, communication, prediction, hypothesis, inference, experimentation, interpretation of data, research controlling variable and generalization etcetera. At the secondary level, the foundation of chemistry education is laid as they are taught the underlying principles.

The low achievement of learners in chemistry has been variously explained. According to Usman and Memeh (2007), the factors that negatively affect chemistry achievement include students background problems; students lack of interest and negative attitude towards chemistry; teacher related factors like poor preparation; inadequate qualified chemistry teachers, inadequate instructional materials and application of poor teaching methods. In Nigeria efforts are being made by researchers, government and non-governmental organization to improve cognitive, affective and psychomotor outcomes in chemistry. For instance, a good number of research efforts have been made to diagnose the problems associated with the teaching and learning of chemistry in order to proffer solution that lead to better achievement. Recommendations have been made regarding the teaching method, instructional materials, home and school related environment factors that could enhance achievement in chemistry. However, evidence available indicates that achievement in chemistry at secondary school remains low and unimpressive.

Also, the teaching of chemistry in the senior secondary school of Nigeria has significance as pointed out by Olatoye and Affuwape (2006) and Mohammed, (2007) are as follows.

- Chemistry helps in improving the quality of our life today; Chemistry allows man to understand his environment and concept of matter and different changes that matter undergoes (Ibrahim 2006). All the household materials such as soaps and detergent for washing, hair cream and perfumes and majority of cooking utensils, plastics material for wide variety of uses are all product of chemical process.
- Chemistry, provides vocational preparation of individuals who will become personnel in the various fields such as medicine, pharmacy, chemical engineering,

textiles, and petroleum industry; among others, these are coessential, particularly in developing country like Nigeria.

- Chemistry education is of practical aesthetic and intellectual value to students. It provides useful chemical concepts and principles. Chemistry is also directly related to other natural science such as physics and biology. Hence the encouragements of the learning of chemistry especially at the senior secondary school level is of paramount importance and one way by which this can be achieved is through the use of appropriate instructional strategy.
- Chemistry contributes towards providing our basic needs and improving the quality of our lives in the following areas;
    i. Agriculture: The production of different type of fertilizers and insecticides has been possible by chemical means, these increases food production greatly. The preservation and storage of food for long period of time is made possible as a result of chemical process, so that food can be stored and exported to a distance place and made available for more people.
    ii. Health: the variety of medicine that is available are as a result of advance chemical researches in chemistry, this researches are financed by pharmaceutical firms, governmental and non-governmental organizations and conducted by chemist.
    iii. Education: Teaching service laboratory assistants/technicians, teachers and lecturers in secondary and tertiary institutions are always of increasing demand; career in chemistry can help you to get employed in these fields.

However, the teachers mainly adopt instructional strategies that are teacher directed and do not encourage deeper students involvement and self-regulation (Kerr, 2003). Self-

regulated learner, who possesses relevant skills which enhance their ability to construct knowledge, assume responsibility for their own learning and realizes that learning, is a personal experience that requires active and dedicated participation (Kerr, 2003, & Peters, 2009). This perception on the role of the learner, in the learning processes is changing the views of educational researchers on the role of the teacher in the learning process. Instead of viewing teaching as teacher exposition followed by students practice, effective teaching may be achieved by integrating teaching-with-analogy on attitude, retention in the process. The teaching with analogy approach to learning locates understanding within the learners not with the teachers. Because, it is the learners who must learn and therefore must take the responsibility for learning.

According to Kerr (2003), learning is based on an appropriate self-reflection which leads to meaningful learning construction. Hence, this study intends therefore to facilitate active participation of the subject in the learning process by providing the condition that allows students take responsibility for their study by changing their attitude, increasing their retention ability and performance in chemistry concepts through employing Teaching-With-Analogy approach.

2.2.1 Teaching of Acids, Bases and Salts Concept in Chemistry

The topic of acids bases and salts had posed many problems to students of various background. For as early as several decades ago, the topic on acids bases and salts has been reported to be difficult for students, who have as a result held several alternative conceptions about acids bases and salts (Artej, Retanaroutai, Coll, & Thongpanchang, 2010).

Acid is from the Latin word “Acidus” meaning “Sour”. It is considered to be any chemical substances that when dissolved in water gives a solution with high concentration

of hydrogen ion activity greater than that of pure water that is a PH less than 7.0. According to Wikipedia (2009) an acid is define as a compound that denotes hydrogen ion (H^+) in solution to another substance called base. Common example 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 ion in a solution (OH^-). Examples of bases include sodium hydroxide used in the manufacture of soap, sodium salt and potassium hydroxide used in the manufacture of dying and in electroplating.

Salts are compounds formed when all or parts of the 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. Examples include sodium tetraoxosulphate(IV) Na_2SO_4. Bsic salt 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. Example Zn(OH)Cl. Acid salt, this is formed when parts of replaceable hydrogen ions are partially replaced by metal, example, potassium hydrogen sulphate $KHSO_4$. Double salt are salts which when ionized produce three different types of ions, in which two are positive (metal ion or ammonium ions) while the other is a negative ion. Complex ion consists of group charged atoms example sodium tetrahydroxozincate (II) $NaZnOH_4$.

In this study Acid Base and Salt concepts were used to investigate the effectiveness of Teaching-With-Analogy on academic performance, retention and attitude of SS II Chemistry students of Zaria metropolis, Kaduna state.

2.3 Constructivism and Analogy in Science Teaching

Constructivism is premised on the belief that learners actively create, interprets and reorganize knowledge in individual ways (Nworgu, 2007). The core idea is that learners actively construct their own understanding rather than passively absorb or copy the understanding of others. The construction of new understanding is stimulated by a problem situation, which disturbs the individual's current organization of knowledge. This disturbance or disequilibrium occurs when his/her current cognitive structure do not adequately solve, explain, predict or allow for navigation within the situation encountered. This disequilibrium leads to mental activities and modification of previously held ideas to account for new experience (Zachariah, 2008).

Constructivist's theory was based on early empirical and theoretical work by Piaget who articulated mechanisms by which knowledge is internalized by learners. Constructivism suggests that students learn science best when they are actively engaged in doing science or in performing activities that allows them to think like scientists. As such, a major emphasis in science curricular reform is a change from a more traditional teacher-based learning to a more inquiry-based, student-centred learning (Usman, 2010).

Constructivism is more than a set of teaching techniques. It is a coherent pattern of expectations that underlie new relationships between students, teachers and the world of ideas. Constructivism has revolutionized the study of learning by emphasizing the individualistic way in which understanding is generated. According to Yara (2009), constructivism central idea is that human learning is constructed, that learners build new knowledge upon the foundation of previous learning.

Today, it is generally recognized that learners do not come to science instruction with a "tabula rasa" (i.e. empty mind) but possess tenaciously held preconceptions concerning the phenomena with which they are familiar (Olaleye, 2005). As the principal tool of education is language, and the teacher's goal is to establish valid grounds for the learner to explore scientist's science, the meaning of individual words and expressions is a vibrant cog in this overall process of developing cogent understanding (Harrison,2002) whenever an analogy is spoken or written, reference is being made to pictures and ideas in long term memory. During learning, the child's preconceptions and misconceptions often act as a barrier to the reception of new, more valid propositions. Treagust, Harsson and Venville (1998) suggest a four stage model for working through such impasses, one element in the process being the use of analogy. An appropriate analogy may serve to arouse relevant familiar concepts in long term memory. Thus, previously learned structural and organizational knowledge may interact constructively with the new challenging experience when the learner holds invalid or flawed concepts, as well as chosen, familiar analogy can act as an appropriate source of conceptual conflict for the student. In the process of restructuring knowledge, the student must first become dissatisfied with his or her prior view. For this to occur, students must be motivated to see a need to improve his or her understanding. Sani, (2006) suggest that analogies can initiate new ideas and understandings within students' conceptual ecology. Strike and Posner recognized that not all new conceptions will even be considered, much less accepted. They list four criteria that ought to be met for conceptual change to occur. These are:

1. There must be dissatisfaction with existing conceptions
2. The new conception must be minimally understood
3. The new conception must appear initially plausible.

4. A new conception should suggest the possibility of a fruitful research program to open up new areas of inquiry.

According to constructivist approach, instructors have to adapt to the role of facilitators. A facilitator helps the learner to get to his or her own understanding of the content. In the former scenario, the learner plays passive role and in the latter scenario the learner plays an active role in the learning process. The emphasis thus turns away from the instructor and the content, towards the learner (Harisson, 1998). This dramatic change of role implies that a facilitator needs to display a totally different set of skills than a teacher. A teacher tells, a facilitator asks, a teacher lectures from the front, a facilitator supports from the back; a teacher gives answers according to a set curriculum, a facilitator provides guidelines and creates the environment for the learner to arrive at his or her own conclusions (Yara, 2009).

To Piaget, "knowledge is the transformation of experience by the individuals, not just the accumulation of pieces of information". In this way the constructivist epistemology provides a sound platform for the study of teaching with analogy. Thus, constructivism currently provides the best explanation for the way an analogy generates meaning during analogical learning. Hence, constructivism is an instructional strategy which incorporates other desirable teaching strategy such as analogy in teaching.

Use of analogy as a constructivist instructional strategy has shown much promise in its application in science teaching. Abimbola and Mustapha (2007) reported that use of analogy in teaching will improve academic performance and retention in the students, as well as encourage active participation of the learners. On the part of the teacher the analogy in teaching enhances professional development of teachers and promotes culture of learning. The effects of teaching- with-analogy in teaching acds, bases and

salts concepts to SSII students of chemistry was employed in this study to find its effectiveness on the performance, attitude and retention of the concepts by the students.

2.4 Instructional Strategies in the Teaching of Chemistry

Teaching method is very important in the impartation of knowledge in teaching/learning processes and the type adopted determines to a greater extent what the students assimilate. Scholars (Atadoga &Onaolopo 2008, Usman 2010; Olorukooba, Lawal & Jiya, 2012) opined that there are variety of methods and techniques for teaching science, and each one of them is associated with a number of advantages and disadvantages. These methods and approaches include; lecture method, inquiry method, analogy method, laboratory technique, demonstration method, discussion method, project method, activity method, simulation method, corporative learning strategy, guided discovery method, concept mapping, among others.

This study therefore, investigated the effects of Teaching-With-Analogy in teaching Acids bases and salts concepts to SS II Chemistry students, to see whether it would improve students' performance, attitude and retention of the concepts taught.

2.4.1 Lecture Method of Instruction

Lecture method is a teaching technique in which one person, usually the teacher, present a spoken discourse on a particular subject (Dienye and Gbamarija, 1990 in. Atadoga and Onaolapo 2008). In this method students are mainly recipients of knowledge as dispensed by the teachers, few questions are asked and notes are taken as the teacher does most of the talking. It is teachers dominated approach of teaching, often termed as dyadic method or chalk and talk approach. (Mukherjee, 2002) opined that lecture method is used for elaborating; simplifying, clarifying and discussing new materials to learners which provide an aesthetically stimulating experience. Effectiveness of lecture method depends on the type of students, circumstances of the class, the subject, educational purposes and

teachers own characteristics and skills (Abdullahi, 1982). At least 80% of scientific information or principles are passed on the students through lecture method (Atadoga & Onaolapo, 2008).

According to Paul & Dantani (2012) a lecture can be an effective method for communicating theories, ideas, and facts to students. The primary aim of lectures is to make sure that they communicate effectively with their students. In order to do so, a lecture method tries to achieve clarity of delivery, clarity of expression and clarity of structure. However, Paul and Dantani (2012) further stated that many teachers use this method of teaching almost exclusively, as it is considered the simplest, and one can cover large amounts of materials in a short period of time. However, this is not the most effective teaching method to teach all students especially younger ones, who often need a more engaging, hands-on strategy in order to learn effectively. This method is unacceptable for learners at the secondary school level who may find abstract thinking not only laborious but objectionable, as they will not be able to relate facts adequately and will certainly be left out of the lesson.

Aikenhead (2011) pointed out that this method is convenient in the university and other institutions of higher learning for impacting knowledge/information.

2.4.2 Analogy as a Teaching Strategy in Chemistry

There are several definitions of analogy. Analogy is an exposition technique used for comparing sets of information which are adequately similar in important aspects to permit transportation of attributes across sets, usually from familiar to unfamiliar. Treagust (1993) defined analogy as a process of identifying similarities between two concepts. Glynn, Russel and Noah (1997) defined analogy as a method of teaching that helps children form initial, mental models of key science concepts, by facilitating the introduction of the concepts in ways that are concrete, meaningful and relevant to children.

Novak, (1999) defined analogy as a learning strategy that was developed as a research tool to represent learner's prior relevant knowledge and later as a tool to enhance meaningful learning. Abimbola (2002) refers to analogies as pictorial, metaphorical or model methods of thinking that suggests areas of similarities between two or more things that require observation and/or experimentation to empirically establish findings. Analogy according to the oxford advanced learners dictionary is a comparison of one thing with another thing that has features that are similar (Hornby, 2006).

Both science and science education literature contain many analogies that are proffered as ways for presenting difficult topics in science. For example, a cell making a protein molecule is linked to tradesmen building a house (Biermann's,1988). Some analogies appear to be quite esoteric example the ping-pong ball torture analogy for enzyme activity (Helser, 2003), the shot gun-diffraction of the light analogy (Murphy & Smoot, 1992). Then there are those analogies that are problematic, in that, they often generate alternative conceptions though they remain popular and are frequently used in science teaching. Example: electric current is like water flowing in a pipe (Harrison, 2001).

Science concepts are full of abstract or challenging concepts that are easier to understand, when related to something from everyday experiences. Thomas and Orgill (2007) reported that teachers made difficult or abstract concept understandable through the use of analogy. Analogies can be useful as instructional tools. Infact, Glynn (2007), Chew (2008) clearly stated that analogies motivates students, clarify students' thought, help students overcome wrong perceptions, and give students ways to visualize abstract concepts, when they are used appropriately. Sani (2006), Treagust, Harrison, Venville and Dagher (1996), all agreed that analogies can also promote students' meaningful learning and conceptual growth and that students are more likely to pay attention to the familiar language used in analogies than to unfamiliar or more "scientific"

terminologies. It is therefore clear that analogy as a teaching strategy would demand, on critical thinking and reasoning on the part of the teacher, as well as creates meaningful classroom interaction for exchanging ideas. The strategy is student-centered, and thus helps to reduce misconceptions among learners.

Ikeobi (2010) and Dagher (2015) showed that analogies are effective conceptual change agents because they enhance understanding by making connections between scientific concepts and the students' life-world experiences, thereby helping students visualize abstract ideas. Dagher pointed out that analogies provoke students' interest and therefore motivate them. Also, he clearly stated that analogies allow new materials, especially abstract concepts, to be more easily assimilated with students' prior knowledge, enabling them to develop a more scientific understanding of the concept.

Brown (2014) identified the following as advantages of the use of analogies in science teachings;

1. facilitates understanding of abstract concepts by pointing to similarities in the real world.
2. provides visualization of the abstract ideas
3. arouses students' interest that may have motivation function.
4. encourages the teacher to take students' prior knowledge into consideration.

In spite of the potentials that analogies might have in promoting the learning of science, several authors have expressed their concern that students often misinterpret the analogies provided by them. In fact, Duit (2011) warned that learning with analogies can create learning difficulties and that students are capable of getting wrong impression from analogies. There is also the tendency that students may confuse analogies with reality except the teacher is capable of showing where the analogy breaks from reality. In other

words, the teacher must be conscious of the limitations of the use of analogy; if the students are to gain from its potentials.

This study therefore, investigated the use of Teaching-With-Analogy in teaching Acids, bases and salts concepts to SS II Chemistry students, to see whether it will improve students' performance, attitude and retention of the concepts taught.

2.4.3 Analogies in Acids Bases and Salts Concepts

One of the analogy studies was done by Kramer (1986). He used " bricklayer analogy". In this study the students are given the description of these different bricklayers. Then he asked the students to rank these bricklayers in order of inherent bricklaying ability. After mentioning average jobs for a day, he asked them "what kind of bricklayer is the bricklayer who needs to do more? And what kind of bricklayer is the bricklayer who do not need to do more even if they are able to do more?" By this time the students have caught on and answer. "A strong and a weak bricklayer".

At the beginning he found out that the students have had difficulty understanding how a given solvent might "disguise" different for some acids not for others. Thus, his general chemistry students have appreciated the following analogy of protons to bricks and seem to understand the concept of a leveling solvent because of it.

Another analogy about Acid-base concept is done by Last (2003). In this study he made use of the practice of one well-known Canadian retail in returning to its customers a small percentage of an items purchase price in the form of imitation bank notes that can subsequently be spent in the chain's stores. An analogy is drawn between this practice and the determination of pka of a weak acid by titrating it with a strong base, taking in to account the hydrolysis of the anion produced.

Like Last (2003), Delorenzo (1995) also studied on acid-base titrations. He employed with "a dating analogy". He used a combination of expanded dimensional

analysis and dating analogies to alleviate this confusion. Many students have trouble calculating titration problem quickly in chemistry classes. Delerenzo gives a few tips for how to answer a titration problem example. In his dating analogy, he considered two dormitories, one for male students and one for female students. The concentration of men in the dorm for males is one per room, and there are four rooms of women in the dorm for females. The following balanced equation tells that exactly one man (M) reacts with one woman (W) to become a dating pair (MW) in much the same way that one gram equivalent of acid reacts with exactly one gram equivalent weight of base. He said that he used this combination of dimensional analysis and dating analogy with his general chemistry classes for many years. The students have found that it gives them a better grasp of these titration problems.

In chemistry there are a number of phenomena that are the net result of competition between two chemical species. Felty (1985) studied about Bronsted-lowry acid-base reaction. During his studies he used "competition analogy". In his analogies fluorine is analogous to the top ranked football team in the league (assuming such rankings are an accurate ordering with respect to ability). When playing the second- ranked team (oxygen), there is stiff competition with little scoring because the two teams are rather closely matched. The top ranked team eventually triumphs, but by a slim margin, say by a score of 7 to 3. Then he considered the game between the same second-ranked team and the tenth-ranked team (hydrogen). In football as in bonding both the winner and the margin of victory depend on a greater deal on one's competitor.

In literature football analogy is not used only by Felty (1985) but also Silvestein (2011) used "football analogy" to explain weak and strong acid-base. In his study he said that partial ionization in a difficult concept for some to comprehend; the phrase may not evoke much in the mind of a "Visual learner". Visual analogies are often helpful when

difficulties like these arise. Hence in his analogy he linked an acid which is a proton donor, to a quarterback. The quarterback is a football "donor", whose job is to deliver the ball by either passing it to a receiver or handing it off to a running back. With all the details of analogy he added that a similar analogy may be drawn between a base and a wide receiver. Also in another study, Silverstein (2011) used the "big dog-puppy dog" analogy. In this analogy, puppy dogs are restricted to a specific dog run; they represent bond electron pairs. Big dogs are allowed to roam freely over several consecutive dogs' runs; they represent delocalized bond electron pairs. By adding a bunny rabbit that is chased by the big dog, the analogy can be expanded to account for delocalized formal charge in a resonance hybrid.

Hence, this study investigated the effectiveness of Teaching-With-Analogy on academic performance, retention and attitude of SS II Chemistry students in Zaria metropolis, Kaduna state.

2.5 Retention and Academic Performance in Chemistry

Permanent and meaningful learning is the ultimate target of our educational endeavor. Understanding and retention are the products of meaningful learning when teaching is effective and meaningful to the students, (Bichi, 2002). Retention is defined as the ability of one to remember what he has learned in the later time, it takes place when learning is coded into memory. Thus, appropriate coding of incoming learning or in coming information provides the index that may be consulted, So that retention takes place without elaborate search (Oyedokun, 1998). Hence, the more active the learner is in the learning process the better he/she retains what is taught, (Paul, 2011).

Retention works together with academic performance. Retention which is the ability to retain things experienced or learned, has an area of focus to some science educators in recent years. Several factors are known to influence retention which include;

learners past experiences, instructional strategies employed, interval between lesson and evaluation, among others.

Bichi, (2002), Reports that anything that aids learning should improve retention while things that cause confusion or interference among learned materials decrease the speed of efficiency of learning and accelerate forgetting. Retention level in relation to age has been investigated by several researchers. Jimerson Carlson, Robert, England and Shroufe (1997) reported that retention increases from infancy throughout the teenage years followed by a slow recession in middle age. Studies on retention and instructional strategy have attracted the attention of many researchers in recent years for instance, Olorukooba, Lawal and Jiya (2012) investigated effect of the use of analogy teaching strategies on academic performance and retention in evolution concepts among NCE biology student, college of education in Niger State. Analysis of the result shows a significant difference in the retention ability of the students taught using analogy compared to those taught using lecture method of instruction. It also shows that the analogy teaching strategy enable students to have a better understanding of concepts taught and retain more knowledge of evolution concept than the lecture methods.

A large proportion of the literature reviewed showed that emphasis in science education is no longer on the transmission of factual knowledge, but on teaching students how to learn. However, this study examined how Teaching-With-Analogy strategy and lecture method affects students' retention ability when taught Acids-bases and salts concepts of chemistry.

2.6 Students Attitude and Academic Performance in Science

An attitude toward science denotes interest or feelings towards studying. Attitudes are general expression of either positive or negative feelings towards something and this distinguishes it from other terms like value, belief or opinion (Koballa & Glynn 2007). It is

the students disposition towards ‘’like’’ or ‘’dislike’’. While attitude in science means scientific approach assumed by an individual for solving problems assessing ideas and making decisions (Yara, 2009). Developing favorable attitudes towards science has often been listed as one of the important goal of science teaching.

For the present study, the term attitude in used to refers to ones feelings, thought and predisposition to behave or respond to in some particular manner. According Mukherje (1978), attitudes are best expressed when individuals makes statement about their feelings or opinion. Hence, the study of students attitude to learning and instruction is important. Balogu (1985) asserted that, the possession of a favorable attitude towards science is an important characteristic of scientifically literate person. She also found out from her study that attitude was significantly related to academic performance in science. However, recent research suggests that students' performance also depends on academic enablers such as attitudes and behavior that allow the students to participate in and ultimately benefit from academic instruction in classroom (Liza 2010). Students attitudes about the value of learning sciences may be considered as both an input and outcome variable because their attitude towards the subject can be related to academic performance, in ways that reinforce higher or lower performance (Koballa & Glynn 2007).

Studies by Brown (2004) and Anderson (2008) have shown that students attitude towards science seems to improve through the use of some instructional procedure or models. This support Nwagbo (2011) assertion that attitude may be modified by instruction. This means that, the method of instruction could affect performance and attitude as well. The students' attitude towards chemistry needs to be assessed during the lesson so that we can know how they feel towards our teaching strategies, classroom activities and the subject matter. This will assist the teacher in providing good basis for accepting useful educational invention to facilitate chemistry learning. (Muhammed, 2007)

Bannett, Rollnick, Green and white, (2009) stated that researchers demonstrate that there is a link between the cognitive and affective domain. Therefore, chemistry education goals should embrace the two and not treat them as mutually exclusive domains. The Implication is that attitudes can be developed and much of the studies in literature indicate that the approach to presentation and organization of the curriculum goes a long way to determining the development of desired attitudes in students. There are four areas where attitudes are important:

- Attitudes towards chemistry
- Attitudes towards topics and themes in chemistry;
- Attitudes towards the learning of chemistry;
- Scientific attitudes

Zacharia (2005) stated that much research has shown clearly that a negative attitude towards chemistry is the dominant factor affecting students' willingness to study chemistry further. Based on social psychological models, it has been shown that attitudes towards topics and themes in chemistry are developed by means of interactive teaching materials (Bennett, Rollnick, Green and White 2001). However, it is against this background that this study seeks to determine whether Teaching-With-Analogy can be used to improve students' attitude towards chemistry.

2.7 Gender and Academic Performance in Chemistry

The concept of Gender in teaching and learning process has attracted the attention of many researchers. Several studies had examined the influence of gender on students' academic achievement. For example, Olatoye and Adakoya (2010) found no gender difference in academic achievement in cooperative and competitive learning groups. Oyedekun (1998) reported the significant influence of gender on academic performance with boys having better scores than girls in the study.

On the issue of gender, Usman (2007) and Ogunkola (2009) found out their various studies that, boys perform well in any rigors work while girls shows to settle for less rigorous work. Mari (1994) and Bichi (2008) in their separate studies have showed that girls perform better than boys in problem solving type of activities. In another dimension, if boys and girls are giving equal opportunities, they will perform equally well (Yoloye 2004 & Nworgu, 2007). The issue of gender in science teaching seems to be controversial. The differences in the scholastic achievements of boys and girls are generally attributed to biological causes, cultural and stereotypes (Nworgu, 2007). The last two decades have been devoted to addressing gender inequality in education some studies have shown, low participation of women in education. Researchers have therefore expanded tremendous efforts in the study of the personal factors affecting academic performance especially in the sciences and social sciences. Notable among these variables is the study of the phenomenon of gender or sex equity in education.

In Nigeria, gender issues abound in all spheres of the society. The educational conditions of the girl-child vis-à-vis the boy child constitute an important gender issue. In our cultural setting, the cultural and traditional responsibilities of men and women are different; hence the influences in the upbringing of the female and male children. Hence, this study is particularly interested in determining the effectiveness of Teaching-With-Analogy instruction on gender when taught Acids-bases and salts concepts of chemistry.

2.8 Overview of Similar Studies

Olusanya (1998) opined that analogies have been identified in the literature to be potent in enhancing knowledge and skills acquisition in science. Studies on the use of analogies in science teaching have indicated that teachers use analogy in their normal classroom settings when they believe that there exist a need for it (Chew, 2002) or when as

a result of the teacher's experience and knowledge he or she anticipates that students will not understand a concept.

Dagher (2015) used 54 Senior Secondary School Class II Physics students which is equivalent to SSII in Nigeria. She made a study on conceptual change effects of the analogy and they conducted three (3) months interview on the students in Delaware State, USA. The study used 29 students who were taught refraction using wheels analogy and 25 students were taught the same concept without analogy by the same teacher. Both groups were interviewed and were scored. When the differences in the mean scores were compared, the interview result revealed that students taught with analogy had better understanding of the concept taught than those taught without analogy. Both classes were of comparable ability and achievement before treatment through the result of the first interview used as pretest. The analogy group students performed significantly better because the students' concept learning was enhanced by the spontaneous introduction of familiar experiences. The students were able to make connection between the analogy target and their experiences which leads to better performance as seen on the part of the treated group. Successful connections like these enrich the analogical mappings because the students see how the science concept explains their everyday happenings. The researcher left an important variable unabridged which is the attitude of the students, which the present researcher tried to bridge.

Jiya (2012) investigated the effects of teaching-with-analogy on academic performance and retention of evolution concepts among NCE biology students, in Minna Niger State. A total of 280 students consisting of 100 females and 180 males formed the sample for the study. Purposive sampling technique was used. The subjects were divided into two groups; the experimental group N=135 and the control group N=145. The study adopted the pretest, posttest, post-posttest quasi experimental and control group design. A

pretest was administered before the treatment to establish the equivalence of the experimental and control groups. The subjects in the experimental group were taught using Teaching-With-Analogy (TWA), while the control group subjects were exposed to the lecture method for a period of six weeks. The topics taught were evolution concepts. The research instrument, Evolution Achievement Test (EAT) was adopted from biology textbook questions and past moderated NCE III examination questions. These were validated for data collection. Three null hypotheses were tested. t-test statistic was used to determine significant difference of the two groups at $p \leq 0.05$. The major findings from the study include the following: there is significant difference in the mean academic performance scores of experimental and control groups in favor of experimental group. There is a significant difference in the retention ability of the students taught using analogy compared to those taught using lecture method of instruction in favor of experimental group. On the gender related issue Teaching-With-Analogy favored male students over the female. Based on the findings it was concluded that NCE biology students learn evolution concepts better when taught using teaching-with-analogy it was therefore recommended that Teaching-With-Analogy should be used by biology teachers to teach the concepts of evolution. From this study there is need to pay attention to specific aspects of teaching with analogies in the context of SSII students. The study was relevant to the present study because it served as a guide to teachers' preparation. Also this research work has given the present researcher an insight as it has some variables in common but left some which is retention in which the present researcher tried to fill.

Yıldırım, Şengün, Ceng and Ayas, (2010) in their study, investigated the effects of analogy-based and laboratory-based instruction on the teaching of chemical equilibrium on students achievement. The sample composed 65 students from a high school in Ankara, Turkey. The main aim of the research was to find out the effect of analogy and laboratory

based instructions on student achievement about chemical equilibrium in comparison with traditional instruction. Semi-experimental research method was used. The classes were randomly determined as two experimental groups and one control group. A semi-structured interview and unstructured observation were used as data gathering instruments. The data collected were analysed using descriptive analyses. At the end of the study a significant difference was found in favor of the laboratory group over analogy, and a significant difference was found in favuor of the experimental groups over the control group. This research work has given the present researcher an insight as it has some variables in common but left some which are retention and attitude in which the present researcher is trying to fill.

Nworgu (2007) worked on analysis of restructuring alternative conceptions of physics students using analogy and a five step conceptual change instructional model on Senior Secondary School students. The sample for the study consisted of 186 SSII students from four selected secondary schools in Enugu State. Out of the four secondary schools, two schools were assigned to the five step conceptual change instructional models group while the remaining two schools were assigned to the analogy group. The two groups were taught simple electric circuit. Physics Achievement Test (PAT) developed by the researcher was used to collect data. Generally, 93.5 percent of the students had alternative conceptions on electric circuit before treatment while only 6.5 percent of the students had scientific conceptions before instruction took place. After treatment 92 percent of the students who possessed alternative conceptions before treatment shifted to scientific views after formal instructions took place. Effects of analogy and therefore five steps conceptual change instructional models achievement did not differ significantly.

The findings confirmed that students develop ways of interpreting the world around them and also the finding of this agrees with Nowrgu (1996) that students bring to the

school learning ideas, expectations and beliefs concerning natural phenomena which they have developed prior to their school learning. The study findings conformed to Nworgu (1997) views that constructivist based methods like those used for this study result in a conceptual shift or change. Nworgu's study was relevant to the present study in that analogy adopted as constructivist learning approach was used which is the focus of this study.

Owolabi (2007) worked on the use of analogy as vehicle for achieving effective physics delivery in some selected senior secondary schools in Lagos. The study sample consisted of 112 senior secondary school II physics students drawn from two randomly selected secondary schools in Lagos, Nigeria. The test was to find out specific information regarding the concepts of mirror and lenses which many students often confuse or use interchangeably. The result showed that the experimental group performed significantly better and retained more of the concepts than the control group after a post posttest. It shows that there is statistically significant difference between the mean scores of experimental and control groups. This was an indication that there is significant influence of analogy on students' performance in physics. Owolabi's study is relevant to the present study, in that he used analogy to clarify concepts of mirror and lenses which students usually confuse or used interchangeably. The finding of these study were of relevance to the present study in that it guided the researcher to select problems and also use the strategy in teaching concepts of Acid-base and salt to SS II chemistry students, but left an important variable which is the attitude of students which the present researcher addressed.

Sani (2006), made a study on effect of analogy on conceptual understanding of chemical equilibrium among SS2 students. Eighty SS2 students in Minna Niger State were used for both experimental and control group. The instruments used for posttest were two forms of multiple-choice chemistry tests which were used for data collection, the result

obtained from the data analysis indicated that scores of the experimental and control groups before the treatment were 23.3 for experimental group and 24.9 for control group. This indicated that there is no statistically significant difference between the mean score of experimental group and the mean score of the control group at the 0.05 significant level ($t=1.81$, $df=39$, $p<0.05$). Thus the two groups were equivalent before the treatment. The result of the posttest mean scores of the experimental 56.7 and control groups 31.3 indicates that there is statistically significant difference between the mean scores of the experimental group and control group at the 0.05 level ($t=1.52$, $df=39$, $p<0.05$). Thus, the null hypothesis was rejected. The experimental group taught with analogy performed significantly better than the control group taught with lecture method. The significant difference observed could be attributed to the effect of the experimental strategy which had increased conceptual understanding of the chemical equilibrium and consequently higher performance of the experimental group. Sani (2006) study was relevant to the present study in that student in senior secondary school performed better when analogy was employed in teaching chemical equilibrium. The findings served as a guide for the present study.

Harrison (2002) investigated the effects of using analogies in chemistry teaching a case study of a teacher's preparations, presentations and reflections in Australia. chemistry teachers with 16 years' experience participated in this case study. The Grade – 11 chemistry lessons studied were reaction rates, reversible reaction and equilibrium. Before each lesson, the teacher was interviewed about his intentions while after each lesson; the teacher was interviewed about his reflections on his teaching. The interviews mostly focused on the use of analogies for explaining relevant chemistry concepts. The lessons and interviews were audio taped and transcribed and the transcripts were analyzed individually by both authors. Using investigator triangulation, the analyses were compared and discussed until consensus was established concerning the in-class interactions and the

teachers analogical explanations. The result showed that the teacher presented seven analogies to his students and the analysis reveals that the teacher appeared to be aware of the relevant correspondences, but was not aware of the differences, especially the absence of his intended attention to the limitations of specific analogies, and the absence of his intended check of students understanding of links between an analogy and its target. The teacher was very experienced in telling analogical stories. From this study there is need to pay attention to specific aspects of teaching with analogies in the context of SSII students.

Yilmzoglu (2004) conducted a study to explore the effectiveness of analogy-enhanced instruction accompanied with concept maps over traditionally designed chemistry introduction on understanding of acid-base concept and attitude towards chemistry as a school subject. 81 11^{th} grade students (which is equivalent to SSII in Nigeria) from two classes of a chemistry course taught by the same teacher in Nuh Eskiyapan primary school Ankara, Turkey, were enrolled in the study. There were two groups of students. During the treatment, students in the control group were instructed only with traditionally designed instruction. Students in the experimental group studied with the analogy-enhanced instruction accompanied with concept maps through teacher lecture. Acid-Base Chemistry Achievement Test and attitude scale toward chemistry was administered to both groups as pretest and posttest as pretest and posttest, logical thinking ability test was given to both groups at the beginning of the study to determine student's logical thinking ability levels. Data were analyzed by using ANCOVA and t-test. As a result of the research, it was obviously seen that analogy-enhanced instruction accompanied with concept maps caused a significantly better acquisition of scientific conception related to acid-base and produced significantly higher positive attitudes towards chemistry as a school subject than the traditionally designed chemistry instruction. This study was relevant to the present study in that students in senior secondary school

performed better when analogy was employed in teaching Acid Base and Salts concept. But the researcher left an important variable unabridged in which the present researcher tried to bridge which is retention ability of the students.

These examples are inexhaustible; the ones listed here are just to give insight and to stimulate science teachers and educators to use their knowledge, experience and creative thinking in developing appropriate analogy in their teaching. In this study therefore, Teaching-With-Analogy was employed to find their effectiveness on performance, attitude and retention of concepts in acids bases and salts concepts at secondary school level.

2.9 Implications of the Literature Reviewed to the Present Study

Researchers (Harison, 2005; Sani 2006, Owolabi 2007, Jiya 2012, Oloyode, 2013) revealed that students in secondary schools had difficulties in learning abstract concepts in science. To ensure meaningful learning and therefore, improve academic performance, attitude and retention, several and specific instructional strategies and approaches that are suitable to bring readiness to the problem have been found in the literature. One of such instructional strategy that is gradually gaining research attention of recent time is Teaching-with-analogy strategy for students learning scientific abstract concepts. From the literature cited, most of the studies carried out were using different concepts, different instructional strategies, different approaches and study area. Hence the present study examined the effects of Teaching-With-Analogy strategy on students' performance, retention and attitude in Acids Bases and Salts concepts among senior secondary school students.

Meaningful learning is proximate to educational strive. The literature also revealed that, the use of indirect instructional strategies (for example TWA strategy) have been found to contribute significantly to the growth and development of science education. Direct instructional strategies (example lecture method) was found to be less effective in improving students' academic achievement in science. This has implication on exploring

effective strategy for teaching sciences. Attempt had been made to discuss the effect of gender on academic achievement in science. The overwhelming literature revealed that, the achievement of students irrespective of gender differences in science is a function of the teaching strategy adopted by the teacher in the classroom. The teaching strategy could influence students' academic achievement and attitude positively or negatively. A good number of instructional strategies have been developed by scholars to influence the academic achievement of students in science. The implication of this is that, it gave the researcher an insight to use lecture method as a teaching method to control group. The present study therefore was undertaken on Acids Bases and Salts concept of chemistry to find out the relative effectiveness of Teaching-With-Analogy strategy on students' performance, retention and attitude in Acids Bases and Salts concepts among senior secondary school students of Zaria Metropolis, Nigeria.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The study examined the effects of Teaching-With-Analogy on secondary school students' attitude, retention and academic performance in chemistry, in Zaria Metropolis, Kaduna State- Nigeria. This chapter presents a description of the methodology employed for the study under the following sub-headings:

3.2 Research Design

Quasi-experimental and control group design involving Pretest, Posttest and Post-posttest was used for the study. It involved two groups in which one group was assigned as experimental, and the other as control group. The same pretest on performance and attitude ($\mathbf{O_{1P}}$A) was administered to the chemistry students in the two groups before the treatment. This was to determine the equivalence of the two groups in their ability in the Acids Bases and Salts Concepts. The Experimental Group (EG) received experimental treatment (X_1)

which was Teaching–With-Analogy (TWA) while the Control group (CG) was taught using lecture method. At the end of the six weeks treatment, a posttest on performance and attitude (**O_{2PA}**) was administered to the two groups to determine the students' post academic performance and post attitude in Acids Bases, and Salt Concepts. After two weeks, a post posttest was administered to the students to determined their level of retention. The design is represented in figure 3.1

EG → O_1PA → X_1 → O_2PA →O_3PA
CG → O_1PA → X_0 → O_2PA → O_3PA

Figure 3.1: Research Design Illustrated
Key:

EG = Experimental group- exposed to TWA

CG = Control group - exposed to Lecture Method

O_1PA = Pretest on academic Performance and attitude

O_2PA = Posttest on academic Performance and attitude

O_3PA = Post-Posttest on academic Performance and attitude

X_1 = Teaching –with –analogy

X_0= Lecture Method.

3.3 Population of the Study

The population of the study comprised all co-educational public Senior Secondary School students offering chemistry in Zaria Metropolis, Kaduna State-Nigeria. There are thirteen co-educational public Senior Secondary Schools with population of one thousand six hundred and eleven (1611) Senior Secondary School (SSII) students in the study area, according to Zonal Inspectorate of Education Zaria (ZIEZ, 2015). Public schools were used because their organizational structure, condition of teaching and learning and mode of operations are relatively the same. The population involved one thousand and seventy-five

(1075) male and five hundred and thirty six (536) female SS II students with an average age of 17 years. The study population is presented in Table 3.1

Table 3.1: Population of the Study

	Name of Schools	Type of School	No. of Males	No. of Females	Total
1.	GSS Tudun jukun, zaria	Co-educational	168	54	222
2.	GSS Magaiya (Snr)	Co-educational	74	36	110
3.	GSS Aminu (Snr)	Co-educational	124	58	182
4.	SF ASSS Karaukarau	Co-educational	12	8	20
5.	GSS Kaura	Co-educational	152	98	250
6.	GSS Dakace	Co-educational	87	35	122
7.	GSS Yakasai	Co-educational	76	55	131
8.	GSS Tudun Sebu	Co-educational	59	23	82
9.	GSS Dinya	Co-educational	8	4	12
10	GSS Kugu	Co-educational	16	9	25
11	GSS Kofan Kuyanbana	Co-educational	170	80	250
12	GSS Muchia (Snr)	Co-educational	72	51	123
13	GSS Likoro	Co-educational	57	25	82
	Total		**1075**	**536**	**1611**

Source:(Zaria Education Zone, 2015)

3.4 Sample and Sampling Technique

The sample of the study constituted a total number of 192 SSII chemistry students selected from two public co-educational secondary schools in the study area. Random Sampling technique was used to select six(6)schools out of the 13 schools in the study population in the Educational Zone. A General Chemistry performance test was administered to (SSII) students in each of the six schools selected to determine their equivalence in terms of academic performance. This was achieved by subjecting the students test scores for the six schools to Analysis of Variance (ANOVA) and Scheffe's test. Two schools were purposely selected based on the fact that their mean scores were not

significantly different. The status of the schools was determined using simple random sampling technique involving balloting. The names of the two schools were written on a piece of paper, folded and placed in a container. The papers were picked without replacement and placed into two different containers labeled as experimental and control groups.

As a result of this exercise, GSS Magajiya was assigned the Experimental Group while GSS Tudun Saibu the Control Group respectively. The sample subjects for each school was intact classes of one hundred and ten (110), for experimental and eighty two (82), for control groups respectively. The choice of one hundred and ninety two (192) students as a sample size was in line with central limit theorem recommendation, which suggested that a minimum of thirty (30) participants can be used to establish a relationship between groups in experimental research as noted by (Tuckman, 1975). The sample selected is presented in Table 3.2.

Table 3.2: Sample of the Study

s/no	Name of schools	No. of males	No. of Females	Total
1.	GS S Magajiya	74	36	110
2.	GSS Tudun Sebu	59	23	82
	Total	133	59	192

Source: Zaria Educational Zone (2015)

3.5 Instrumentation

The research instruments that were used by the researcher for this study are:

1. Acid Base Performance Test (ABPT)
2. Chemistry Attitude Questionnaire (CAQ)
3. Lesson Plan

3.5.1 Acid Base Performance Test (ABPT)

The instrument Acid Base Performance Test (ABPT) was developed by the researcher from Senior Secondary School Certificate Examination (SSCE) past questions, New School Chemistry Textbook, and National Examination Council (NECO) because is already standardized. It consists of 30 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 asked to provide the correct answers to them.

3.5.2 Chemistry Attitude Questionnaire (CAQ)

The Chemistry Attitude Questionnaire (CAQ) which was adopted from Muhammad (2011) was used for attitude testing before and after the treatment. The CAQ has two parts; Part I sought 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 chemistry learning. The Likert scale was 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, i.e, 1, 2, 3, 4 and 5 respectively for strongly agree, to strongly disagree for negative statements. The details of instruments are given in Tables 3.3

Table 3.3: Table of Specification

Content	Weight (100%)	Know. (33%)	Comp. (22%)	Appl. (10%)	Anal. (10%)	Synth. (10%)	Eval. (10%)	Total.
Acid	**55**	**8**	**3**	**3**	**2**	**4**	**2**	**14**
Base	**20**	**3**	**1**	**1**	**2**	**1**	**0**	**13**
Salt	**25**	**1**	**4**	**1**	**1**	**1**	**2**	**13**
	100%	**12**	**8**	**5**	**5**	**6**	**4**	**40**

Source: Bloom (1956)

3.5.3 Validation of the Research Instruments

The instrument (ABPT) was validated by three experts; PhD holders in Chemistry Department and Science Education Department, Ahmadu Bello University, Zaria. The experts examined the instruments and observed whether the items in the instrument

- match the ability of the students
- are suitable for SSII students,
- test what they were set to test,
- and check for possible errors in the suggested answers.

The experts checked the instruments and corrected some of the errors observed and certified that the instruments were relevant in measuring Academic Performance and attitude in acids bases and salts concepts. For example, sulfuric acid was corrected to tetra oxosulphate(VI)acid.

The Chemistry Attitude Questionnaire (CAQ), was presented to three experts in Science Education, and Educational Psychology and Counseling Departments, with a minimum qualification of Ph.D in Ahmadu Bello University, Zaria, for validation. The experts checked the instruments and made some corrections. For example, question 19 was a repetition of question 16 as such it was discarded.

The two research instructional instruments: Teaching-with-analogy Lesson Guide (TWALG) and Lecture lesson Guide (LLG) were also validated by three experts in Science Education.

3.5.4 Pilot Testing

Pilot Testing for the two instruments (ABPT and CAQ) was carried out with an intact class of SSII chemistry students in GSS Tudun Jukun, one of the schools in the study population. The pilot testing was conducted under a very strict condition and no student was allowed to go out with the question paper in order to avoid leakage of the items in the

two instruments which might in turn affect the final posttest result. The purpose of the pilot testing was to ascertain:

- the approximate time that would be required by the respondents to complete the test. (i.e 40mins)
- the reliability of the instruments
- the characteristics of the test item (i.e difficulty index and discriminating index of the items).

3.5.4.1 Reliability of the Instruments

The Reliability of ABPT was determined by administering the test twice using test-retest method with two weeks interval in line with Tuckman, (1975) recommendation. The results of the two tests was correlated using Pearson Product Moment Correlation Co-efficient statistics, a coefficient of 0.86 was obtained. The r-value recorded was significant at 0.05 alpha levels; hence ABPT is reliable instrument for the study. While, the reliability coefficient of CAQ was determined by administering the CAQ once to an intact class of SSII students in GSS Tudun Jukun in the study population, Spearman Rank Order Correlation was used to estimate the reliability for the CAQ the result obtained was 0.76. Thus, the instrument was reliable to determine the attitude level of the students toward Acids Bases and Salts Concepts.

3.5.4.2 Item Analysis

Item analysis was achieved by examining the difficulty level and discrimination index of the items; this is because the quality of a test item depends on how far each item meets these two criteria. Each item must be relevant to the course content, neither too easy nor too difficult, and must discriminate between weak and good students. The items in the ABPT was analyzed to determine the item difficulty index and the item discrimination index. According to Sambo (2008) the items difficulty index is the percentage of the

students that get an item right over the total number of students that attempted the item and it is determined by the formula:

$$P = \frac{R}{T} \times 100$$

Where p = item difficulty

R = Number of students who answer an items correctly

T = Total number of students who attempted the item.

The items difficulty index was computed in line with Sambo, (2008) who reported that, in the normal research literature, item with index between 40-60% are accepted. In this study, items with facility index of 40-60% was used. Items with facility index below or higher than 40-60% was changed or modify for being too difficult or too simple.

Discrimination Index: The discrimination index (DI) of a test items is the capacity of such a test to discriminate or distinguish between high and low achievers among students in the sample. It gives room for the ranking of students in the test. If an item shows positive discrimination index, it implies that large proportion of some competent students than poor ones get the item right. In a situation whereby the items discrimination value is zero, it implies that the items are unable to distinguish between high and low achievers in a given sample of students. While the negative discrimination index is indicating that more poor students got the items right compared to more competent students. The calculation was done using scores of the top twenty seven percent (27%) and bottom twenty seven percent (27%) of the total respondents. This was calculated using the formula given by Frust, (1958) and used by Sambo, (2008) which is:

$$DI = \frac{RU - RL}{T}$$

Where:

DI = Discrimination Index

RU = Number among upper 27% who responded correctly to the items.

RL = Number among lower 27% who responded correctly to the items.

T = Number of respondents in both group.

In line with Frust, (1958) and Sambo, (2008) items with discrimination index ranges between 0.40 and 0.70 were regarded as moderately positive and was accepted for the present study. And items which did not fall within the accepted ranges of 0.40 and 0.70 was rejected. This was used in selecting the final items of the Acid Base Performance Test (ABPT) (see appendix 3).

3.6 Administration of the Treatment

Two different treatment patterns were maintained throughout the study (Teaching Acids Bases and Salts concepts using TWA and Lecture method). Two different Lesson guides (TWA lesson plan and Lecture method lesson plan) addressing the same instructional objectives and content of Acids bases and salts was used for experimental and control groups respectively. The plan for experimental group was based on TWA which provide opportunities for students to learn under the guidance of the researcher. In contrary, students in the control group were taught by the researcher using lesson planned based on conventional lecture method. The treatment lasted for six (6) weeks. Experimental group were taught using Teaching–With-Analogy (TWA) Model (Glynn, 2007). In this model, ideas from a familiar concept (the analogue) were transferred to an unfamiliar one (the target). If the analogy and the target shared some similarity in their features, an analogy was drawn between them. The process of comparing the features is called mapping.

Teaching–With-Analogy (TWA) model is preferred to other Analogy model for this study because the model simplifies a difficult concept or idea, provides a variety of

approach to link an unfamiliar idea with a familiar idea and visualizes a structure or process. Above all, it puts into consideration the prior knowledge of the learner, which constructivist view that meaningful learning must necessarily involves students in integrating new information or knowledge with pre-existing schemata (Millar, 1989).

Teaching–With-Analogy (TWA) Glynn (2007) model consists of six steps that the teacher carries out when drawing an analogy.

1. Introduce the target concept,
2. Resview the analogy concept,
3. Identify the relevant features of target and analogy,
4. Map the similarities,
5. Indicate where the analogy breaks down,
6. Draw conclusions.

In adopting TWA model for this study, all the six steps were followed accordingly;

1. Introduce the target concept to be learned

This step can be anything from a brief introduction to a full explanation depending on how the analogy is to be utilized. If the analogy is to be used as an advance organizer, then the target concept would be introduced after the analogy. The analogy may also be used for reviewing the concept(s) in which case, the target concepts is fully taught at this stage, for example, definition of Acid and Base.

2. Cue the student's memory to the analogous situation

This step involves the introduction of the analogy and determines the student level of familiarity through questioning and/or discussion. If student understanding is low, the analogy is modified or the process is aborted. The teacher should ensure that there is at least one obvious similarity for the students between the analogy and the target. Example, the football Analogy is used to explain Bronsted-Lowry Acid and Base

3. Identify the features of the analog that are relevant

This step involves explaining the analogy to the students at a level that is appropriate to their understanding and which will accurately identify the features of the analogy that was used to build concepts in the next stage.

4. Map the similarities between the analogy and the target concepts

Item by item, the analogy features are linked with the target concepts. There may be a one-to-one correspondence from analogy to target, two or more analogy features may converge on a single target concept or a single analogy attribute may develop two or more target concepts. Example, Acid and Base was mapped with the football analogy

5. Identify where the analogy breaks down

During the mapping exercise, the students may suggest inappropriate links. Other invalid transfers that the teacher may be aware of can now be combined with the student's alternative conceptions for discussion at this point. These conceptions should be discussed so that the student can distinguish the valid from the invalid. This step can be integrated into the discussion at any appropriate point.

6. **Drawing conclusions about the target concept**

As in all teaching, a succinct summary of what has been learned about the target concept from the analogy should be stated to facilitate student learning.

3.6.1 Treatment to the Experimental Group

The teaching of the Concepts was conducted by the researcher. This was to ensure that the teaching procedure was followed accordingly as required by the model. It also removed teacher bias that might arise when using research assistants. Teaching last for 6 weeks, precisely two hours per week based on lesson note. The experimental group were taught using Teaching- With-Analogy (TWA) model of Glynn (2007).

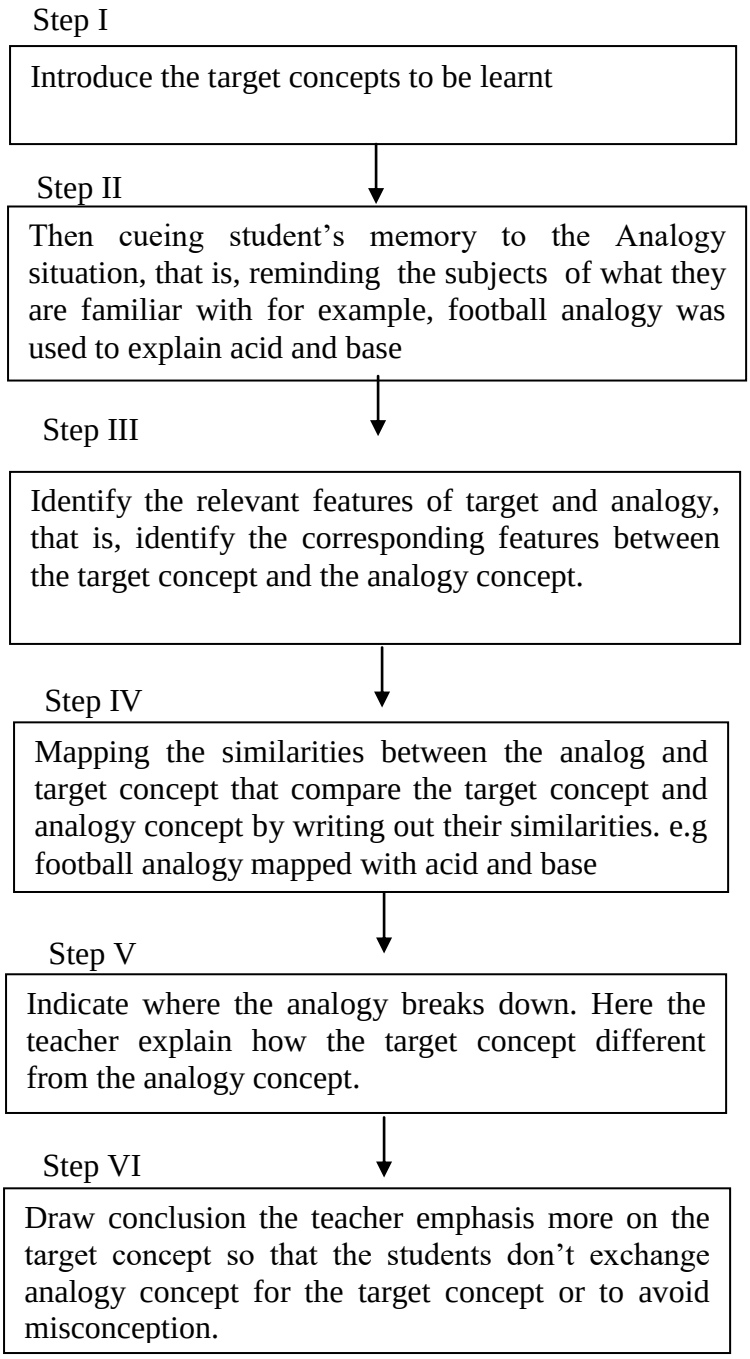

Fig 3.2: Teaching-With-Analogy flowchart
Source: Glynn (2007)

3.6.2 Treatment of the Control Group

The control group students were taught the same concepts by the researcher using lecture method. Two hours per week for six (6) weeks was used. The pretest was administered to the subjects before the commencement of the teaching. The lesson was

presented by defining the term or concept then followed by the explanation and important points were written on the chalkboard. The subjects were referred to relevant Chemistry text books for more information. Written assignment was given to the subjects after each lesson.

3.7 Data Collection Procedure

Two instruments were used for data collection namely Acid Base Performance Test (ABPT) and Chemistry Attitudes Questionnaire (CAQ). ABPT was used as pre-test and posttest, and post-posttest, while CAQ was given to the experimental group as attitude pretest and attitude posttest.

3.8 Data Analysis

The data collected was analyzed using t-test statistic to test the null hypotheses and mean to answer the research questions.

H01: There is no significant difference between the mean scores of chemistry students taught Acids Bases and salts concepts using Teaching-With-Analogy and those taught using lecture method.

This hypothesis was analyzed using t-test statistics.

HO2: There is no significant difference between the mean scores of male and female chemistry students taught Acids Bases and salts concepts using Teaching-With-Analogy.

This hypothesis was analyzed using t-test statistics.

HO3: There is no significant difference in the retention ability of students taught Acids Bases and salts concepts using Teaching-With-Analogy and those taught using lecture method.

t-test statistics was used to test this hypothesis.

HO4: There is no significant difference in attitude of chemistry students, taught using Teaching-With-Analogy and those taught using lecture method.

The data collected was analyzed using Mann-Whitney U-test-statistics.

CHAPTER FOUR

DATA ANALYSIS, RESULTS AND DISCUSSION

4.1 Introduction

This study was carried out to investigate the Effects of Teaching-With-Analogy on attitude, retention and performance in chemistry among secondary school students, in Zaria metropolis. For the purpose of data collection, Acid Base Performance Test was used as an instrument for data collection. The data collected were analyzed using Statistical Package version IBM 23 and the level of significance adopted for rejecting or retaining the stated null hypotheses was at $p \leq 0.05$. This chapter was discussed under the following subheadings:

- Data Analysis and Result Presentation
- Summary of Major Findings
- Discussion of Results

4.2 Data Analysis and Results Presentation

The Data collected from the study using Acid Base Performance Test and Chemistry Attitude Questionnaire were analyzed and used to answer the research questions and test the null hypotheses.

Research Question One: What is the difference between the performance means scores of students taught chemistry concepts using Teaching-With-Analogy and those taught using lecture method?

Descriptive statistics in form of mean and standard deviation were used to answer this question as shown in Table 4.1.

Table 4.1: Mean and Standard Deviation of Posttest Mean Scores of Experimental and Control Groups

Groups	N	Mean	Standard Deviation	Mean Difference
Experimental	110	20.68	3.65	5.40
Control	82	15.28	3.61	

Results from Table 4.1 shows that, the performance mean scores of experimental and control groups were 20.68 and 15.28 respectively, with a mean difference of 5.40. This answers the research question and experimental group performed better than the control group, and this can be attributed to the treatment i.e Teaching-With-Analogy.

Research Question Two: What is the difference between the performance mean scores of male and female students taught chemistry concepts using Teaching-With-Analogy strategy?

The mean and standard deviation of posttest academic performance of male and female students in experimental group were computed as shown in Table 4.2

Table 4.2: Descriptive Statistics on Difference between the Performance Mean Scores of Male and Female Students in Experimental Group only

Gender	N	Mean	Std.dev	Std.Err.	Mean Difference
Male	74	20.68	3.53	0.41	0.02
Female	36	20.66	3.94	0.65	

Results from Table 4.2 shows that the computed performance mean scores of male and female students are 20.68 and 20.66 respectively with a mean difference of 0.02 in favor of male. This implies that male students taught acids, bases and salts concepts using Analogy perform better than the female students.

Research Question Three: What is the effect of teaching-with-analogy on retention ability of students in chemistry concept?

To test this research question, the post-posttest performance means scores of the experimental and control groups were compared. The result is shown in Table **4.3**

Table 4.3: Mean and Standard Deviation of the Post-Posttest Scores of Experimental and Control Groups

Groups	N	Mean	Std.dev	Std.Err	Mean difference
Experimental	110	19.06	3.33	0.22	
Control	82	14.56	2.55	0.19	4.07

Results from Table 4.3 shows that the computed performance mean scores of the experimental and control group are 19.06 and 14.56 respectively with a mean difference of 4.07. This means that the experimental group achieved higher than the control group, and this can be attributed to the treatment i.e. the use of Teaching-With-Analogy.

Research Question Four: What is the effect of Teaching-With-Analogy and lecture method on the attitude of students towards chemistry?

To test this research question, mean rank and sum of rank posttest attitude scores of experimental and control group were computed as shown in Table **4.3**

Table 4.4: Mean Rank and Sum of Rank Posttest Attitude Scores of Experimental and Control Groups

Group	N	Mean Rank	Sum of Ranks
Experimental	110	136.85	15053.00
Control	82	42.38	3475.00
Total	192		

Results from Table 4.4 shows that, the computed Mean Rank attitude scores of the experimental and control groups were 136.85 and 42.38 respectively, while their computed

sum of Rank scores are 15053.00 and 3475.00. This implies that significant positive effect exist in their mean attitude rank as a result of teaching chemistry concepts with Analogy.

4.3 Hypotheses Testing

Null Hypothesis One: There is no significant difference between the performance mean scores of chemistry students taught chemistry concepts using Teaching-With-Analogy and those taught using lecture method.

To test this hypothesis, the posttest mean scores of students in experimental and control groups were subjected to t-test statistics and summary of the analysis is shown in Table 4.5

Table 4.5: Results of t-test Analysis of Posttest Mean scores of the Experimental and Control Groups

Variables	N	Mean	Std.dev	Std.Err	Df	t-cal	P	Decision
Experimental	110	20.68	3.65	.34				
				.	190	10.16	0.01	Significant
Control	82	15.28	3.61	39				

Calculated p < 0.05, calculated, t calculated > 1.96 at df 190

Table 4.5 shows that, the calculated p value of 0.01 is lower than the 0.05 alpha level of significance. Their computed performance mean scores were 20.68 and 15.28 by students taught chemistry concepts using teaching-with-analogy and those taught using lecture method, respectively with a mean difference of 5.40 in favor of those taught chemistry concepts using Teaching-With-Analogy. This implies that significant positive effect exist as a result of teaching chemistry concepts using Teaching-With-Analogy. Therefore the null hypothesis which state that there is no significant difference between the performance mean scores of chemistry students taught chemistry concepts using Teaching-With-Analogy and those taught using lecture method, is rejected.

Null Hypothesis Two: There is no significant difference between the performance mean scores of male and female students taught chemistry concepts using Teaching-With-Analogy.

To test this hypothesis, the posttest mean performance scores of male and female students in experimental group were subjected to t-test statistics and summary of the analysis is shown in Table 4.6.

Table 4.6: Results of t-test Analysis of the Posttest Mean Scores of Male and Female Students in the Experimental Group

Variables	N	Mean	Std.dev	Std.Err	Df	t-cal	P	Decision
Male	74	20.68	3.53	.41				
					108	0.03	0.97	Not Significant
Female	36	20.66	3.94	.65				

Calculated p > 0.05, calculated, t calculated < 1.96 at df 108.

Table 4.6 shows the calculated p value of 0.97 is higher than the 0.05 alpha level of significance. Their computed performance mean scores are 20.68 and 20.66 by male and female students taught chemistry concepts using Teaching-With-Analogy respectively with a mean difference of 0.02 in favour of male students. This implies that the use of teaching chemistry concepts with analogy produces the same effect on male and female students performance mean scores. Therefore the null hypothesis which state that there is no significant difference between the performance mean scores of male and female students taught chemistry concepts using Teaching-With-Analogy is retained.

Hypothesis Three: There is no significant difference between the retention ability of students taught chemistry concepts using Teaching-With-Analogy and those taught using lecture method.

To test this hypothesis, the post-posttest mean performance scores of students in experimental and control group were subjected to t-test statistics and summary of the analysis is shown in Table 4.7.

Table 4.7: t-test Analysis of Post-posttest Performance Mean Scores of Experimental and Control Groups

Groups	N	Mean	Std.dev	Std.Err	Df	t-cal	P	Decision
Experimental	110	19.06	3.33	.22	190	6.10	0.006	Significant
Control	82	14.56	2.55	.19				

Calculated p < 0.05, calculated, t calculated > 1.96 at df 190.

Table 4.7 shows that, the calculated p value of 0.006 is lower than the 0.05 alpha level of significance. The computed mean scores of their retention ability were 19.06 and 14.56 by students taught chemistry concepts using Teaching-With-Analogy and those taught using lecture method, respectively with a mean difference of 4.50 in favor of those taught chemistry concepts using Teaching-With-Analogy. This implies that significant positive effect exist in their retention ability as a result of teaching chemistry concepts using Teaching-With-Analogy. Therefore the null hypothesis which states that there is no significant difference between the retention ability of chemistry students taught chemistry concepts using Teaching-With-Analogy and those taught using lecture method, is rejected.

Hypothesis Four: There is no significant difference in the attitude of students towards chemistry between students taught using Teaching-With-Analogy and those taught using lecture method.

To test this hypothesis, the posttest mean scores of students in experimental and control group were subjected to Mann-whitney U-test statistics and summary of the analysis is shown in Table 4.8.

Table 4.8: Results of U-test Analyses of the Attitude Scores of the Experimental and Control Groups

Group	N	Mean Rank	Sum of Ranks	Z	U-value	P	Decision
Experimental	110	136.85	15053.00	11.66	72.00	0.01	Significant
Control	82	42.38	3475.00				

P<0.05

Table 4.8 shows that, the calculated p value of 0.01 is lower than the 0.05 alpha level of significance and the calculated Man Whitney U value of 72.00 is higher than the Z value of 11.66 Their computed Mean Rank attitude scores were 136.85 and 42.38 by students taught chemistry concepts using Teaching-With-Analogy and those taught using lecture method, respectively while their computed sum of Rank scores are 15053.00 and 3475.00 by students taught chemistry concepts using Teaching-With-Analogy and those taught using lecture method, respectively. This implies that significant positive effect exist in their mean attitude rank as a result of teaching chemistry concepts with analogy. Therefore the null hypothesis which states that there is no significant difference in the attitude of students towards chemistry when taught using Teaching-With-Analogy and those taught using lecture method is rejected.

4.4. Summary of Major Findings

The findings of the study are as follows:

- There was significant difference between the performance mean scores of the experimental and control groups in favour of the experimental group. This implied that the subjects in the experimental group taught acids bases and salts concepts using Teaching-With-Analogy Strategy performed significantly better than the subjects in the control group taught the same concepts using lecture method.

- There was no significant difference between the performance mean scores of male and female students taught acids bases and salts using Teaching-With-Analogy in the experimental group. Thus Teaching-With-Analogy is gender friendly.
- There was significant difference between the post-posttest mean scores of students retention ability in the experimental and control groups. This implied that the subjects in the experimental group taught acids bases and salts concepts using Teaching-With-Analogy Strategy retained better the concepts taught than the subjects in the control group taught the same concepts using lecture method.
- There was significant difference between the posttest attitude scores of students in the experimental and control groups in favor of students in experimental group. This implied that significant difference effect exist in their mean attitude rank as a result of teaching chemistry concepts with TWA.

4.5 Discussion of the Results

The objectives of the study were to investigate the effects of Teaching-With-Analogy on attitude retention and performance in chemistry among secondary school students in Zaria metropolis, Kaduna State Nigeria. To achieve this aim, students in experimental group taught using Teaching-With-Analogy while students in the control group were taught using lecture method. The results of the analysis of data are here by discussed.

In Table 4.5 the result of testing hypothesis one showed that there was a significant difference in the mean academic performance scores of students exposed to Teaching-With-Analogy and those taught with lecture method. The significant difference found between the two groups was due to the use of Teaching-With-Analogy on the experimental group. If the treatment administered has no effect, the two groups are expected to perform equally the same. Since the experimental group performed significantly better, it implies

that using teaching-with-analogy in teaching chemistry students improves the students' performance.

The finding is in agreement with that of Yilmmozoglu (2004) and Jiya (2012), who in their separate studies revealed that students learn better when tought using teaching-with-analogy and produce higher positive attitudes towards chemistry as a school subject than the traditional lecture method of instruction. This might be due to change in mode of instructions that is from teacher-centre (i.e. lecture method) to students-centre (i.e. teaching-with-analogy). The results was in accordance with the findings of Lagoke, Jegede and Harrison (2002) and Sani (2006) who found in their separate studies that students taught using TWA performed better than students taught using lecture method.

On the issue of gender in relation to academic performance when exposed to Teaching-With-Analogy and lecture method, the results in Table 4.7 shows that there is no significant difference between the two groups in terms of their mean academic performance scores, this shows that the activity-based methods of instruction such as teaching-with-analogy, problem solving and process approach among others is adequate in enhancing the academic performance of the two groups (both male and female) This finding is in agreement with those of Olatoye (2006), Usman (2010) who found out that there is no significant difference between male and female achievement in science. The finding gains further support from the work of Adekoya and Olatoye(2011) who reported that there is no significant effect of gender on students achievement in an aspects of agricultural sciences that is pasture and forage crops. The finding is also in agreement with that of Bichi (2000) who observed that the type of instructional method used does not discriminate between male and female.

From the findings in Table 4.7, the study revealed that there was a significant difference in the retention level of the students in experimental and control groups. This

shows that the Teaching-With-Analogy used enabled the students in the experimental group to retain more knowledge of the concepts taught. This is because the strategy allowed new materials, especially abstract concepts, to be more easily assimilated with the student's prior knowledge, enabling them to develop a more scientific understanding of the concept. This aid the memory retention resulting in higher performance of the students. This is in line with the findings of Owolabi (2012) who reported that Teaching-With-Analogy can clarify students doubt on specific information regarding scientific concepts, thus leading to better performance and retention of concepts compared to the lecture method. Olorukooba, Lawal and Jiya (2012) ascertained that, there is a significant difference in the retention ability of students taught using analogy compared to those taught using lecture method of instruction.

The analysis of the results in Table 4.8 indicates that there is significant difference in the attitude of chemistry students taught using Teaching-With-Analogy as compared with those taught using lecture method. The significant difference could be as a results of the use of Teaching-With-Analogy which is superior to the lecture methods. These findings is in accordance with the findings of Yilmozoglu (2004) who reported that analogy-enhanced instruction accompanied with concept maps caused a significantly better acquisition of scientific concepts related to acid-base and produced significantly higher positive attitudes towards chemistry as a school subject than the traditionally designed chemistry instruction. It is also in line with that of Brown (2004), and Anderson (2008) who showed that students attitude in science seems to improve through the use of some instructional procedures. This study therefore indicated that Teaching-With-Analogy can enhance attitude, retention and performance in chemistry among Secondary school students in Zaria metropolis Kaduna State Nigeria.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This study investigated the effects of Teaching-With-Analogy on attitude, retention and performance in chemistry among secondary school students in Zaria metropolis. The data collected were analysed using mean and t-test statistical tools. This chapter is presented in the following sub-headings:

- Summary of the Study
- Major Findings
- Conclusion
- Recommendations
- Contributions to Knowledge
- Limitations of the Study
- Suggestions for Further Study

5.2 Summary of the Study

This study investigated the effects of Teaching-With-Analogy on attitude, retention and performance in chemistry among secondary school students in Zaria Kaduna State Nigeria. Four research questions and four null hypotheses were formulated and tested using independent t-test at 0.05 level of significance. The study also reviewed related literature based on the following subheadings: nature of chemistry and its teaching in secondary school level, teaching of acids, bases and salts concept in chemistry, instructional strategies in the teaching of chemistry, lecture method of instruction, analogy as a teaching strategy in science. analogies in acid-base and salts concepts, students' retention and academic performance in chemistry, students attitude and academic performance in chemistry,

gender and academic performance in chemistry, overview of similar studies and implications of literature review for the present study.

The study adopted the pretest, posttest and post posttest quasi experimental and control group design. A pretest was administered before the treatment to establish the equivalence of the experimental and control groups ability levels. The students in the experimental group were taught using teaching-with-analogy while those in the control group were taught using lecture method for the period of six weeks. The concepts taught was acids, bases and salts from senior secondary school curriculum. The instrument used for the study was Acid Base Performance Test (ABPT). One hundred and ninety two (192) students were randomly selected from thirteen (13) senior secondary schools which constituted the sample for the study from the total population of one thousand six hundred and eleven(1611) SSII students in the zone.

5.3 Major Findings

The followings are the summary of the major findings

1. Significant differences existed between the mean scores of chemistry students taught chemistry concepts using Teaching-With-Analogy and those taught using lecture method in favour of the students taught using TWA.
2. There was no significant difference between the mean scores of male and female students taught chemistry concepts using teaching-with-analogy.
3. Significant differences existed between the retention ability of chemistry students taught chemistry concepts using Teaching-With-Analogy and those taught using lecture method in favour of those taught using TWA.
4. Significant differences existed in the attitude of students towards chemistry when taught using Teaching-With-Analogy and those taught using lecture method in favour of those taught using TWA.

5.4 Conclusion

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

a) Students performed better in Acids, Bases and Salts concepts when taught using Teaching-With-Analogy

b) Students at senior secondary school level had better retention of concepts when taught acids, bases and salts concepts using Teaching-With-Analogy.

c) The use of Teaching-With-Analogy is gender friendly as it promotes academic performance, attitude and retention of male and female students.

d) Students in the experimental group have a significant change in attitude towards chemistry at secondary school level when taught using Teaching-With-Analogy.

In conclusion on the findings of this study, Teaching-With-Analogy has the potential of enhancing secondary school students performance, attitude and retention of Acids, Bases and Salts concepts.

5.5 Recommendations

From the findings of this study, the following recommendations were made:

1. Curriculum planners should examine the efficacy of Teaching-With-Analogy strategy and recommend it for translating the curriculum at the classroom level where appropriate.
2. The use of lecture method of teaching has been found to be less effective in this study with respect to academic performance attitude and retention of chemistry students. Science teachers should therefore exercise their expertise and caution in the use of lecture method to avoid a situation, where under performance is promoted among senior secondary school level.

3. In service training for science teachers in form of seminars, workshops and conferences should focus more on how to use teaching-with-analogy for the teaching of basic science concepts. The government or relevant professional bodies like Science Teachers' Association of Nigeria (STAN) could do this.
4. Textbook publishers should produce textbook in science subjects using TWA strategy.

5.6 Contributions to Knowledge

The concern of this study was to explore the effects of Teaching-With-Analogy on Academic performance and retention of acids bases and salts concepts among secondary chemistry students in Zaria metropolis, Kaduna state Nigeria. The findings of this study have a significant contributions and great implication for educational practices:

1. The Acid Base Performance Test (ABPT) was designed and developed by the researcher using the six levels of mental process of cognitive domains outlined by Bloom, to test students' performance in Acids Bases and Salts Concepts and found to be effective. Thus, unique in this field.
2. The Chemistry Attitude Questioneer (CAQ) was developed by the researcher for the purpose of testing the attitude of students in Acids Bases and Salts Concepts, and students taught using TWA developed positive attitude towards Acids Bases and Salts Concepts. This serves as contribution to knowledge.

5.7 Limitations of the Study

The following limitations were noted in the course of this study:

1. The schools used for this study were state owned only. If other secondary schools such as Federal, Private owned were included, it might affect the scope of generalization made on the findings, thus a limitation to this study.

2. The use of two schools as a sample is a limitation observed by the researcher. If more schools were involved in the study, it might affect the scope of generalization.

5.8 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, which should be carried out using teaching with analogy strategy with the view to find out whether similar or different result could be obtained.

(ii) By extending the study to other secondary schools to see if the use of teaching with analogy will yield better learning outcome.

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APPENDIX 1

Acid Base Performance Test (ABPT)

SECTION A: Biodata of respondent

Location of School:……

Class:……..

Age:……...

MALE [ ] FEMALE [ ]

SECTION B contains 30 multiple-choice questions and 10 fill in the blank spaces you are required to fill in the blanks spaces provided.

SECTION A

1. According to the Arrhenius theory an acid is any substance which:
   a. Reacts with water to form salt
   b.. Reacts with salt to form base
   c. Dissociates in water to produce hydrogen ions H+1
   d. Dissociates in water to produce hydroxyl in OH
2. Strong Acid
   a. Reacts fast
   b. Dissociates completely
   c. Dissociate partially
   d. Has no water in it
3. A pure concentrated tetraoxosulphate(VI)acid is non-electrolyte, because;
   a. it contains hydroxyl ion OH-1
   b. it contains no ion at all
   c. it contains hydrogen H+1
   d. its ions are not free to move. e. it is corrosive
4. Write equation to show how CI3C COOH behaves as an Arrhenius acid:
   a. $Cl3CCOOH + H2O \rightleftharpoons Cl3\ CCOO + H_3O^+$
   b. $Cl3\ CCOOH + H_2O \rightleftharpoons Cl3CCOO + H_3O^+$
   c. $CH3\ CCOOH + H2O \rightleftharpoons Cl3CCOOH_2 + HO$
   d. $Cl3CCOH + H2O \rightleftharpoons Cl3CCOO + H^+$

5. According to Bronsted – Lowry concept, an acid is a
   a. Proton acceptor
   b. Proton donor
   c. Electron pair donor
   d. Electron acceptor
   e. non of the above

6. According to Bronsted – Lowry concept NH_3
   a. Is an acid
   b. Is a base
   c. Is a salt
   d. None of the above

7. What is the conjugate form 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 reacts 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-1 d. H+1

10. Which of the following acids is strongest than all:
    a. H_2SO_4 b.H2SO_3
    c. HCl
    d. H_3O+
    e HNO_3.

11. Sour milk contains
    a. Mitocondra 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 100cm3of 5M solution of tetraoxo sulphate(VI) acid solution to 2M you add
    a. 250cm3 of distilled water
    b. 500cm3 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) refers to 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 defined as;
    (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 hydrogen nitrate 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 (VI) 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 The characteristic properties of an acid is due to the presence of …….
(a) hydroxyl ions
(b) hydride ions
(c) hydronium ions
(d) oxide ions
(e) nitrite

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) tetraoxo sulphate (vi) acid

21. A weak base has _____ conjugate acid and a weak acid has a _____ conjugate base
a. Strong, strong
b. Weak, strong
c. Strong, Weak
d. Weak, Weak

22. The dissociation constant of an acid HA is given by
a. $K_a = \frac{[H^+]\,[A^-]}{[HA]}$ b. $K_a = \frac{[H^+]^2\,[A^-]^2}{[HA]}$ c. $K_a = \frac{[H^+]\,[A]^2}{[HA]}$ d. $K_a = \frac{[H^+]\,[A]}{[HA]}$

23. The dissociation constant K_b for a base BOH is given by
a. $K_b = \frac{[B^+]\,[H^+]}{[BOH]}$ b. $K_b = \frac{[B^+]\,[OH^-]}{[BOH]}$ c. $K_b = \frac{[B^+]\,[OH^-]^2}{[BOH]}$ d. $K_b = \frac{[B^+]\,[OH^-]^2}{[BOH]}$

24. A salt derived from a strong base and a weak acid will give salt that is……...
    a. acidic
    b. basic
    c. neutral
    d. volatile

25. $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$
    The above equation represents
    a. Hydrolysis
    b. Hydration
    c. Neutralization
    d. electron affinity

26. These are type of salts except
    a. Normal salt, acid salt, and basic salt, complex salt and double salt
    b. Normal salt, double salt, acid salt
    c. Complex salt, basic salt, acid salt hydrolyzed salt
    d. Double salt, basic salt, complex salt

27. Which of these is not a hygroscopic salt?
    a. Calcium Oxide
    b. Magnesium Chloride
    c. Copper (II) Oxide
    d. Sodium trioxonitrate V

28. Which of the following is not a salt?
    a. Sodium hydrogen trioxosulphate (IV)
    b. Lead (II) trioxonitrate (V)
    c. Basic Zinc Chloride
    d. Aluminum Oxide
    e. Washing Soda

29. Which pH value indicates a basic solution
    a. -1
    b. 0
    c. 3
    d. 7
    e. 9

30. Acid react with trioxocarbonate (IV) to give
    a. CO_2
    b. NaCl
    c. HCl
    d. KoH

31. Bronsted-Lowry concept of acid is defined as…….
32. Henderson Hesselbalch equation is written as ……
33. A solution has a [H+] as 3.2×10-5moldm-3 the [OH-] of the solution will be.....
34. pH is defined as ……
35. A buffer solution is defined as ……
36. An alkali is defined as ……
37. A suitable indicator for titration of hydrochloric acid against aqueous ammonia is……
38. The general method of preparation of salt is …….
39. An example of acid salt is ……
40. The relationship between pk_a, pk_b, and pk_w …….

APPENDIX 2

MARKING SCHEME OF ABPT

S/NAnswerS/NAnswer

1. C
2. B
3. D
4. A
5. B
6. B
7. B
8. A
9. C
10. D
11. C
12. B
13. A
14. B
15. D
16. E
17. E
18. A
19. C
20. E
21. A
22. A
23. B
24. B
25. C
26. C
27. B
28. D
29. E
30. A
31. K3[Fe(CN)6]
32. PH = PKa + log [conjugate]/[acid]
33. 3.125* 10-10
34. It is the measure of acidity or alkalinity of water soluble substances.
35. buffer solution is a solution of a week acid and its conjugate base
36. An alkali is any substance that produces OH^- ions in water.
37. Methyl indicator
38. by neutralization
39. $NaHSO_4$
40. $Pk_w = pk_a + pk_b$

APPENDIX 3

ITEM ANALYSIS OF ACID BASE PERFORMANCE TEST (ABPT)

ITEM NO	$\frac{R}{T} \times 100$	$\frac{RU-RL}{T}$
	P=	**DI =**
1	54%	0.51
2	51%	0.52
3	52%	0.46
4	57%	0.47
5	45%	0.45
6	41%	0.43
7	49%	0.55
8	49%	0.20
9	55%	0.42
10	46%	0.50
11	52%	0.54
12	49%	0.50
13	50%	0.48
14	50%	0.49
15	48%	0.54
16	46%	0.57
17	53%	0.51
18	56%	0.46
19	49%	0.58
20	54%	0.54
21	51%	0.55
22	44%	0.49
23	45%	0.58
24	49%	0.56
25	49%	0.50
26	58%	0.51
27	51%	0.55
28	56%	0.60
29	48%	0.44
30	45%	0.50
31	49%	0.49
32	46%	0.49
33	44%	0.50
34	49%	0.56
35	47%	0.49
36	56%	0.55
37	50%	0.58
38	46%	0.49
39	44%	0.45
40	52%	0.49

APPENDIX 4

Chemistry Attitude Questionnaire (CAQ)

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				
		SA	A	U	D	SD
1	Teaching with analogy method is the best way of learning chemistry					
2	I prefer to learn chemistry through teaching with analogy method of teaching					
3	More courses should be taught by means of teaching with analogy method					
4	Teaching with analogy provides better asses to scientific method then lecture method					
5	The use of teaching with analogy provides and creates more interaction between students and the teachers.					
6	The use of teaching with analogy creates more interaction between students of chemistry					
7	The use of teaching with analogy method increases motivation for chemistry					
8	The use of teaching with analogy makes chemistry more interesting					
9	The use of teaching with analogy Encourage sense of responsibility					
10	The use of teaching with analogy helps students to learn more chemistry than other methods do					
11	The use of teaching with analogy helps provides better learning experience.					
12	The use of teaching with analogy make heavy demand on the teacher					
13	I like chemistry periods because of my interest to learn the subject.					
14	I know I can do well in chemistry					
15	I admire teachers teaching chemistry					
16	After experiencing the teaching with analogy, I prefer been taught with it.					
17	With the teaching with analogy strategy, it was easier to understand the concepts taught with it					
18	At the beginning of each topic, the learning objectives are clearly spelt out to the learner					
19	It's a preferable method than the lecture method					
20	I am learning chemistry out of will					

APPENDIX 5

LESSON PLANS FOR EXPERIMENTAL GROUP

LESSON PLAN ONE

Subject: **Chemistry**

Topic: **acids, bases and salts**

Sub-topic: **Basic Concepts: definitions of acids, bases and salts**

Duration: **40 minutes**

Class: **SS II**

Age: **15-16 years**

Sex: **Males and Females**

Date:

Teaching Method; Teaching-With-Analogy (TWA) Strategy

Instructional Materials; new school chemistry textbook, charts

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

1. define acids and bases
2. identify acids and bases
3. define salt
4. gives examples of acids and bases and salts

Previous Knowledge; Students have learnt in SS I the basic concept of acids and bases.

Introduction: the researcher introduces the lesson by revising the previous lesson to ensure better understanding of the students.

Presentation; the teacher presents the lesson through the following steps:

Step I: the researcher introduces the topic and analogy by cueing the students' memory to the analogy situation as follows;

- Think of a football game. In the football analogy, imagine that acids are compared to quarterbacks (H^+) in a football game and delivers the ball effectively; while a base is an excellent receiver whose job is to hold on to the ball. That's one way to remember that the one that receive the ball acts like a Bronsted Lowrys base and the one that delivers the ball acts like a Bronsted Lowrys acid . According to bronsted and lowry,

an acid is a molecule that can transfer a proton (H^+) to another molecule while a base is a molecule that accepts protons. in short, bronsted lowry acid gives away protons and a bronsted lowrys base accept protons.

H_2O + HCl → H_3O^+ + Cl^-

- Arrhenius define an acid as a compound that releases H^+ ions in water; and a base is a compound that releases OH^- ions in water.

  $HCl_{(aq)} \rightarrow H^+_{(aq)} + Cl^-_{(aq)}$

  $NaOH_{(aq)} \rightarrow OH^-_{(aq)} + Na^+_{(aq)}$
- Lewis define an acid as an electron pair acceptor, while a base is an electron pair donor.

  A + :B → AB

  Lewis Lewis Complex

  Acid Base

  H^+ + NH_3 → NH_4^+

  Lewis Lewis Complex

  Acid Base
- A salt is a compound formed when all or part of the ionizable hydrogen of an acid is replaced by metallic ammonium ions. Also a salt is an ionic compound which is made up of two groups of oppositely charged ions. The ion with a positive charge is called cation, and the one with a negative charge is called anion. A salt is a compound formed when all or part of the ionizable hydrogen of an acid is replaced by metallic ammonium ions.

Step II; the researcher identify relevant features of the analogue and alongside side with the students map out the similarities of the analogue and the target concept as in;

- Acid and base were previously mapped out with the football analogy

Step III: the researcher asks for retrieval clues;

Students' understanding of the analogy and the connection between the analogues and targets is tested by asking the students to explain or describe their understanding of the concepts from the analogue given in their own words.

Step IV: the researcher further describes the relative strength of acids and bases below;

- **Relative Strength of Acid**

  The strength of an acid depends on its ability to transfer its proton (H^+) to a base to form its conjugate base.

$HA + H_2O \rightleftharpoons H_3O^+ + A^-$

Conjugate Base

$H_3O = H^+$

Therefore $HA + H_2O \rightleftharpoons H^+ + A^-$

Hence $K_a = \frac{[H^+][A^-]}{[HA]}$

Where K_a is a dissociation constant.

- **The relative strength of a base**

According to the Arrhenius concept, a base is a substance which produces OH- ions in aqueous solution. The basic properties of such a substance are due to these hydroxyl ions.

$BOH \rightleftharpoons B^+ + OH^-$

$\therefore$

$$K_b = \frac{[B^+][OH^-]}{[BOH]}$$

K_b = base dissociation constant

Step V: The researcher further state and explain the types of salts as follows:

Types of salts

There are five types of salts

- **Normal salt:**

Normal salt are formed when all the ionizable hydrogen ions in an acid have been completely replaced by metallic ions.

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

$H_2SO_{4\,(aq)} + ZnO_{(s)} \rightarrow ZnSO_{4\,(aq)} + H_2O_{(l)}$

Normal salts are neutral to litmus. However, a few normal salt such as Sodium trioxocarbonate (IV), Aluminum Chloride and Sodium Sulphide will undergo hydrolysis in water to give an acidic or alkaline solution or medium.

Acid Salts

They are formed when the replaceable hydrogen ions in acids are only partially replaced by a metal. They are produced by acids containing more than one replaceable hydrogen ion.

Acid salts result when there is an insufficient supply of metallic ions to replace all the replaceable hydrogen ions in the acids. For example,

$H_2SO_{4\,(aq)} + KOH \rightarrow KHSO_{4\,(aq)} + H_2O_{(l)}$

Basic Salts

It contains the hydroxide ion OH^-. They occur when there is insufficient supply of acid which is needed for the complete neutralization of the base. For example, basic salts have the properties of a base, it turns red litmus blue and will react with excess acid to form normal salt and water.

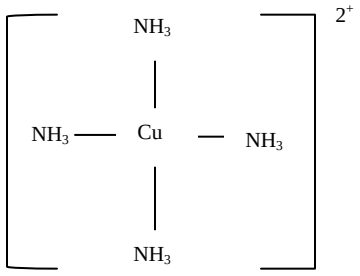
$Ca(OH)_{2\,(aq)} + HCl \rightarrow Ca(OH)Cl_{(aq)} + H_2O_{(l)}$

Double Salts

They are salts which ionize to produce three different types of ions in solution. Usually two of these are positively charged, while the other is negatively charged.

Complex Salts

They are salts formed by mixing together two simple salts. These salts are characterized by the formation of a new ion called complex ion which displays characteristics properties of its own both in the solid state and in aqueous solution. Example: In tetraamine Copper (II) ion. $[Cu(NH_3)_4]^{2+}$



Evaluation; the researcher evaluate the lesson by asking the following questions;

1. Define acids and bases
2. Mention some common acids and bases
3. Explain the relative strength of acid and base.

Summary: The researcher along with the students will highlight main points of the lesson and then give them the opportunity to ask questions if any.

Conclusion; At the end of the lesson, the researcher dictates the note to the students. Students will be asked to read on the next sub-topic which is the characteristics, preparations and uses of acids, bases and salts.

LESSON PLANS FOR EXPERIMENTAL GROUP
LESSON PLAN TWO

Subject: Chemistry
Topic: acids, bases and salts
Sub-topic: Basic Concepts: characteristics, proparties, and uses of acids and bases
Duration: **40 minutes**
Class; **SS II**
Age; **15-16 years**
Sex; **Males and Females**
Date;
Teaching Method; Teaching-With-Analogy (TWA) Strategy
Instructional Materials; new school chemistry textbook, ripe and unripe fruits, sour milk, potash, litmus paper.
Objectives; By the end of the lesson, the students should be able to:

1. State the different types of acids and bases
2. State the characteristics of acid and bases
3. gives the uses of acids, bases and salts

Previous Knowledge; Students have learnt the concept of acids and bases and their relative strength.
Introduction: the researcher introduces the lesson by revising the previous lesson to ensure better understanding of the students.

Presentation; the researcher presents the lesson through the following steps:

Step I: the researcher introduces the topic (target) by cueing the students' memory to the analogy situation as follows;

- Imagine you have an unripe orange, peel it and squeeze the juice, then taste it. You will find out that it taste sour. This sour taste of an acid is one of the properties of an acid. Acid have other properties such as; they change blue litmus paper red, they are corrosive, they neutralizes base, etc.
- Imagine you have potash and then you taste it. You will find out that it taste bitter. This bitter taste of potash is one of the properties of a base. Other properties are: They have bitter taste, They are soapy to touch, turn red litmus blue, The concentrated form of NaOH and KOH are corrosive.

The researcher went further to explain the chemical properties of acids and bases as follows:

Chemical properties of acids

- **Reaction with metals**

Acids reacts with metals like Zinc, Iron and Magnesium to liberate Hydrogen gas.
Acid + Metal → Salt + Hydrogen
$_2HCl + Zn \rightarrow ZnCl_{2\,(aq)} + H_{2\,(g)}$
$H_2SO_{4\,(aq)} + Mg_{\,(s)} \rightarrow MgSO_{4\,(aq)} + H_2$

- **Reaction with base**

Acids react with insoluble bases to form salts and H_2O as the only end product. Such reaction is called neutralization.

Acids + Base → Salt + Water

$H_2SO_{4\,(aq)} + 2KOH_{\,(aq)} \rightarrow K_2SO_4 + 2H_2O_{\,(l)}$

- **Reaction with trioxocarbonates (IV)**

Acid react with trioxocarbonate (IV) to give CO_2

$2HCl + Na_2CO_{3\,(aq)} \rightarrow 2NaCl + H_2O_{\,(l)} + CO_{2\,(g)}$

Chemical Properties of base

- **Reaction with acids**

All base reacts with acids to form salt and water.

$MgO_{\,(s)} + 2HNO_{3\,(aq)} \rightarrow Mg(NO_3)_{2\,(aq)} + H_2O_{\,(l)}$

- **Reaction with Ammonium salts**

They reacts with ammonium salts in the presence of heat to generate ammonia gas.

$Ca(OH)_{2\,(aq)} + 2NH_4Cl_{\,(aq)} \rightarrow CaCl_{2\,(aq)} + 2H_2O_{\,(l)} + 2NH_{3\,(g)}$

Characteristics of Acids

i. **Strong Acids:** they ionize completely in water to give hydrogen ions and anions. Such acids have high concentration of hydrogen ion. E.g.

Hydrochloric acid $HCl \rightarrow H^+ + Cl$

Trioxonitrate (v) acid $HNO_3 \rightarrow H^+ + NO_3^-$

Tetraoxosulphate (VI) acid $H_2SO_4 \rightarrow 2H^+ + SO_4^{2-}$

ii Weak acid: they only partially ionized in water. Such acids in solution have a low concentration of hydrogen ion. E.g.

Trioxocarbonate (IV) acid $H_2CO_3 \rightleftharpoons 2H^+ + CO_3^{2-}$

Tetraoxosulphate (V) acid $H_3PO_4 \rightleftharpoons 3H^+ + PO_4^{3-}$

Ethanoic acid $CH_3COOH \rightleftharpoons H^+ + CH3COO^-$

Step II; the researcher identify relevant features of the analogue and alongside side with the students and map out the similarities of the analogue and the target concept as in;

- Acid and base were previously mapped out with football analogy
- The properties of an acid was previously mapped out with the sour taste of an unripe fruit
- The properties of a base was previously mapped out with the bitter taste of potash.

Step III: the researcher asks for retrieval clues;

Students' understanding of the analogy and the connection between the analogues and targets is tested by asking the students to explain or describe their understanding of the concepts from the analogue given in their own words.

Step IV: the researcher further explain the uses of acid and bases to the students as follows:

Uses of acids

Acids are used in the production of fertilizers, detergents, drugs, in making of fruit juice, they are also used as drying agents, oxidizing agents and catalysts.

Uses of Alkalis (Base)

They are used in the manufacture of glass, soap, paper, rayon. Some alkalis are also used to soften hard water.

Uses of Salts:

They are used in the manufacture of many industrial, agricultural and consumer substances like chlorine gas, fertilizers and laxatives. They are also used as food preservatives, drying agents and antifreeze.

Evaluation; the researcher evaluate the lesson by asking the following questions;

1. State the different types of acids and bases
2. Mention some common properties of acids and bases
3. Give more examples of chemical equations indicating the acid and base.
4. List the uses of acid and bases and salts.

Summary: The researcher along with the students will highlight main points of the lesson and then give them the opportunity to ask questions if any.

Conclusion: At the end of the lesson, the researcher dictates the note to the students. Students will be asked to read on the next sub-topic which is deliquescence, hygroscopic and efflorescence substances.

LESSON PLAN FOR EXPERIMENTAL GROUP
LESSON PLAN THREE

Subject: **Chemistry**
Topic: **acids, bases and salts**
Sub-topic: **Basic Concepts: Neutralization**
Duration: **40 minutes**
Class: **SS II**
Age: **15-16 years**
Sex: **Males and Females**
Date;
Teaching Method: **Teaching-With-Analogy (TWA) Strategy**
Instructional Materials; new school chemistry textbook, table salt, Sodium chloride.
Objectives: By the end of the lesson, the students should be able to:

1. Define neutralization
2. Explain the process of neutralization.
3. Write a neutralization reaction.

Previous Knowledge; Students have learnt about Acids and Bases and salts, and how to use litmus paper in testing Acids and Bases.

Introduction: the researcher introduces the lesson by revising the previous lesson to ensure better understanding of the students.

Presentation; the researcher presents the lesson through the following steps:

Step I: the researcher introduces the topic and analogy by cueing the students' memory to the analogy situation as follows;

The researcher asks the students questions on acids and bases as follows: what is the analogy you can use to describe an acid and base? They might probably say unripe and ripe fruits for acids and potash and ashes for base. The researcher went further to explain that if an acid is gradually added to a base, it results to the formation of salts and water. This process is called neutralization. Hence, neutralization is a process in which an acid reacts completely with an appropriate amount of a base to produce salts and water only. Also neutralization is the combination of hydrogen ions, H^+, and hydroxide ions, HO^-, to form water molecules H_2O and salt.

- Although acids and bases have different chemistries, the acid and base cancel each others chemistry to produce a rather innocuous substance which is water. In fact the general reaction between an acid and a base is

  Acid + Base → water + Salt

  For example, the balanced chemical equation for the reaction between HCL(aq) and KOH(aq) is

  $HCL_{(aq)} + KOH_{(aq)} \rightarrow H_2O_{(l)} + KCL_{(aq)}$

Where the salt is KCL. By counting the number of atoms of each element, we find that only one water molecule is formed.

Step II; the researcher identify relevant features of the analogue and alongside side with the students map out the similarities of the analogue and the target concept as in;

- Acid and base were previously mapped out with football analogy
- Properties of acids were previously mapped out with the sour taste of unripe orange
- Properties of bases were previously mapped out with the bitter taste of potash
- Neutralization was mapped with sour taste of unripe orange and the bitter taste of potash

Step III: the researcher asks for retrieval clues;

Students' understanding of the analogy and the connection between the analogues and targets is tested by asking the students to explain or describe their understanding of the concepts from the analogue given in their own words.

Step IV: the researcher further give some examples of neutralization reaction, as:

i. $2HCL_{(aq)} + Mg(OH)_{2(aq)} \rightarrow 2H_2O_{(l)} + MgCL_{2(aq)}$

Here the salt is $MgCL_2$

ii. $2HOCL_{(aq)} + (Na)_2CO_{3(aq)} \rightarrow 3H_2O_{(l)} + 2NaCL_{(aq)}\, 2HCL_{(aq)} + CO2_{(g)}$

Evaluation; the researcher evaluate the lesson by asking the following questions;

i. Define salt
ii. Give the types and uses of salt
iii. Explain salt hydrolysis and give examples

Summary: The researcher along with the students will highlight main points of the lesson and then give them the opportunity to ask questions if any.

Conclusion; at the end of the lesson, the researcher write the note on the board for the students to copy.

LESSON PLAN FOR EXPERIMENTAL GROUP
LESSON PLAN FOUR

Subject; **Chemistry**
Topic; **Acids, bases and salts**
Sub-topic; **Basic Concepts: deliquescent, Efflorescence and hygroscopic substances**
Duration; **40 minutes**
Class; **SS II**
Age; **15-16 years**
Sex; **Males and Females**
Date;
Teaching Method; **Teaching-With-Analogy (TWA) Strategy**
Instructional Materials: New school chemistry textbook, table salt, sodium hydroxide, quicklime Objectives; By the end of the lesson, the students should be able to:

1. Define efflorescence, deliquescence and hygroscopic substances
2. give examples of efflorescence, deliquescence and hygroscopic substances
3. explain the meaning of the terms drying agents and desiccants

Previous Knowledge; Students have learnt the properties, types and reactions of acids and bases.

Introduction: the researcher introduces the lesson by revising the previous lesson to ensure better understanding of the students.

Presentation; the researcher presents the lesson through the following steps:

Step I: the researcher introduces the topic and analogy by cueing the students' memory to the analogy situation as follows;

Deliquescent, efflorescent and hygroscopic Substances

There are certain compounds that are exposed to air, they either lose their water of crystallization or they absorb moisture from their surroundings. The terms efflorescent, deliquescent and hygroscopic are used to describe such compounds.

Efflorescence: Think of our wet clothes that we dry under the sun. after a little while the the clothes becomes dry. All the water on the clothes is released or evaporates in to the surrounding. That's one way of describing efflorescence. As such efflorescence is the spontaneous loss of water by a hydrated salt, which occurs when the aqueous vapour pressure of the hydrate is greater than the partial pressure of the water vapour in the air. An example is the washing soda molecule which loses nine out of its ten molecules of water of crystallization when exposed to the atmosphere.

$Na_2CO_3.10H_2O_{(s)} \rightarrow Na_2CO_3H_2O_{(s)} + 9H_2O_{(l)}$

Also $Na_2SO_4.10H_2O$ is also efflorescent.

Deliquescence: Think of table salts, if a salt is poured on the floor after some days, the salt becomes liquid. That is, it is exposed to the atmosphere and becomes liquid. This is an example of a deliquescence substance. Deliquescence is a process by which a compound or substance absorbs moisture from the atmosphere so that they eventually turn into solution. Examples are:

- Sodium hydroxide

- Iron (III) Chloride
- Potassium hydroxide
- Calcium chloride
- Magnesium chloride
- Phosphorus (V) oxide

Hygroscopic: Think of a table salts, if a salt is exposed to the atmosphere after a while it becomes wet, this shows that it absorbs moisture from the surrounding, as such it is hygroscopic in nature. That is it is exposed to the atmosphere and becomes wet. Hygroscopic substance are substances that absorbs moisture from the exposure to the atmosphere. Examples of hygroscopic substances include:

- Sodium trioxonitrate (V)
- Copper (II) oxide
- Quicklime

Step II; the researcher identifies relevant features of the analogue and alongside side with the students map out the similarities of the analogue and the target concept as in;

- Acid and base were previously mapped out with the football analogy
- Properties of acids were previously mapped out with the sour taste of unripe orange
- Properties of bases were previously mapped out with the bitter taste of potash
- Neutralization was mapped with sour taste of unripe orange and the bitter taste of potash
- Deliquescence and hygroscopic substances were mapped out with the table salt analogy.
- Efflorescence was previously mapped out with the drying of wet clothes analogy.

Step III: the researcher asks for retrieval clues;

Students' understanding of the analogy and the connection between the analogues and targets is tested by asking the students to explain or describe their understanding of the concepts from the analogue given in their own words.

Step IV: the researcher further describes drying agents or desiccants below;

Drying agents or desiccants' are substances that have a strong affinity for moisture or water. They may be either hygroscopic or deliquescent. They are usually used to dry gases in the laboratory. They are also commonly used in desiccators. A drying agent cannot be used if it reacts with the substance to be dried. For example concentrated tetraoxosulphate (VI) acid cannot be used to dry ammonia since they react to form ammonium tetraoxosulphate (VI).

$2NH_{3\,(g)} + H_2O \rightarrow (NH_4)_2SO_{4\,(aq)}$

Evaluation; the researcher evaluates the lesson by asking the following questions;

1. Define ef**flo**rescence, deliquescence and hygroscopic substances.
2. Give examples of ef**flo**rescence, deliquescence and hygroscopic substances
3. Explain drying agents or desiccants.

Summary: The researcher along with the students will highlight main points of the lesson and then give them the opportunity to ask questions if any.

Conclusion; at the end of the lesson, the researcher dictates the note to the students. Students will be asked to read on the next sub-topic which is neutralization.

LESSON PLAN FOR EXPERIMENTAL GROUP
LESSON PLAN FIVE
Subject; Chemistry
Topic; acids, bases and salts
Sub-topic; Basic Concepts: PH Scale and Indicators
Duration; 40 minutes
Class; SS II
Age; 15-16 years
Sex; Males and Females
Date;
Teaching Method; Teaching-With-Analogy (TWA) Strategy
Instructional Materials; new school chemistry textbook, different basic and acidic substances, litmus paper, methylorange, phenolphthalein, methylred, etc.
Objectives; By the end of the lesson, the students should be able to:

1. Explain the meaning of pH
2. State what indicators are
3. State the range of Acid and basic pH
4. State the indicators are better for certain reaction.

Previous Knowledge; Students have learnt about Acids and Bases and how to use litmus paper in testing Acids and Bases.

Introduction: the researcher introduces the lesson by revising the previous lesson to ensure better understanding of the students.

Presentation; the researcher presents the lesson through the following steps:

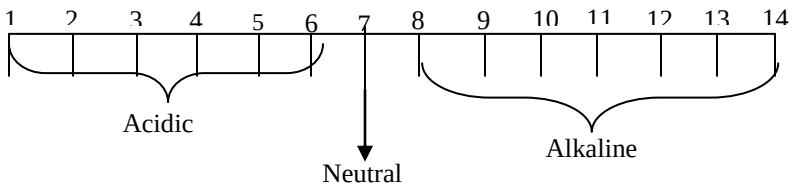
Step I: the instructor introduces the topic and analogy by cueing the students' memory to the analogy situation as follows;

Think of a Cherrie fruit, if a vinegar or lemon juice is added to the cherrie fruit juice, it changes to red and if ashes or bleach or potash is added to the Cherrie juice it colour changes to blue. This is because the vinegar or lemon juice are Acids while potash, ashes and bleach are bases. However there is an instrument that is used to describe the acidity and alkalinity of a substance, and this instrument is known as the PH SCALE. The pH of a solution is a measure of hydrogen ions $[H^+]$ or hydroxonium ions $[H_3O^+]$ concentration of a solution which can be calculated as negative logarithms to base 10 of hydrogen ion $[H^+]$ concentration

$pH = - \log_{10}[H^+]$

Generally pH scale extends from 1-14 and a pH of 7 is neutral; pH value less than 7 is Acidic while pH values greater than 7 to 14 is alkaline. Therefore the smaller the pH value, the more Acidic the solution while the higher the pH value, the more alkaline the solution. Pure water has a pH of 7 therefore it is neutral.

pH – Scale



- The researcher further explains indicators as: take zobo as an example of an indicator. When a basic substance or solution like potash is added to it, its colour changes to blue. This is an example of an indicator because the clour changes when a base is added to it. Hence indicators are compound that changes colour in a solution over a narrow range of PH value. Indicators are weak organic acids and bases that changes colour depending on [H^+] hydrogen or [H_3O^+] hydroxonium ion concentration. Indicators are chemical substances which show different colours in different media. Indicators are weak organic Acids or bases that change colour depending on the hydrogen ion concentration (pH) of the solution. They are used in Acid base titration to detect the end point of a reaction and to test the Acidity or alkalinity of a solution.
- The researcher then gave some groups Acids, others were given Alkali and some groups were given a neural solution. The teacher then gave the student litmus papers and different indicator and draws the table on the board.

Indicator	**Colour change in**		
	Acid	Neutral solution	Alkali
Methyl Orange	Pink	Orange	Yellow
Phenolphthalein	Colourless	Colourless	Pink
Litmus solution	Red	Purple	Blue

Step II; the researcher identify relevant features of the analogue and alongside side with the students map out the similarities of the analogue and the target concept as in;

- Acid and base were previously mapped out with football analogy
- Properties of acids were previously mapped out with the sour taste of unripe orange
- Properties of bases were previously mapped out with the bitter taste of potash
- Neutralization was mapped with sour taste of unripe orange and the bitter taste of potash
- Deliquescence and hygroscopic substances were mapped out with the table salt analogy.
- Efflorescence was previously mapped out with the drying of wet clothes analogy.
- PH was previously mapped out with the cherrie analogy.
- Indicators were previously mapped out with the zobo analogy.

Step III: the researcher asks for retrieval clues;

Students' understanding of the analogy and the connection between the analogues and targets is tested by asking the students to explain or describe their understanding of the concepts from the analogue given in their own words.

Step IV: the researcher further explains to the students the choice of indicator since the accuracy of titration depends on the use of correct indicator therefore; a wrong choice of indicator usually leads to wrong end point.

Strong Acid Vs Strong base	HCl Vs NaOH	7.0	Any suitable indicator methyl orange phenolphthalein
Strong Acid Vs Weak base	H_2SO_4 Vs Na_2CO_3	5-6	Methyl orange
Weak Acid Vs Strong base	$H_2C_2O_4$ Vs NaOH	8-9	Phenolphthalein
Weak Acid Vs Weak base	CH_3COOH Vs NH_4OH	Variable	No suitable indicator

Evaluation; the researcher evaluate the lesson by asking the following questions;

1. Explain the meaning of PH
2. State the range of acid and basic PH
3. What are indicators?

Summary: The researcher along with the students will highlight main points of the lesson and then give them the opportunity to ask questions if any.

Conclusion; at the end of the lesson, the researcher dictates the note to the students.
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LESSON PLANS FOR CONTROL GROUP
LESSON PLAN ONE

Subject: **Chemistry**
Topic: **acids, bases and salts**
Sub-topic: **Basic Concepts: definitions of acids, bases and salts**
Duration: **40 minutes**
Class: **SS II**
Age: **15-16 years**
Sex: **Males and Females**
Date;
Teaching Method: **Lecture method**
Instructional Materials; new school chemistry textbook.
Objectives; By the end of the lesson, the students should be able to:

1. define acids and bases
2. identify acids and bases
3. gives examples of acids and bases

Previous Knowledge; Students have learnt in SS I the basic concept of acids and bases
Introduction: the researcher introduces the lesson by revising the previous lesson to ensure better understanding of the students.

Presentation; the researcher presents the lesson through the following steps:

Step I: the researcher introduces the lesson by defining acid and base as follow;

- According to Bronsted and Lowry, an acid is a molecule that can transfer a proton (H^+) to another molecule while a base is a molecule that accepts protons. In short, Bronsted Lowry acid gives away protons and a Bronsted Lowry's base accept protons.

H_2O + HCl → H_3O^+ + Cl^-

- Arrhenius define an acid as a compound that releases H^+ ions in water; and a base is a compound that releases OH^- ions in water.

$HCl_{(aq)} \rightarrow H^+_{(aq)} + Cl^-_{(aq)}$
$NaOH_{(aq)} \rightarrow OH^-_{(aq)} + Na^+_{(aq)}$

- Lewis define an acid as an electron pair acceptor, while a base is an electron pair donor.

A + :B → AB
Lewis Acid — Lewis Base — Complex
H^+ + NH_3 → NH_4^+
Lewis Acid — Lewis Base — Complex

Step II; the researcher further explain to the students the relative strength of an acid as follows;

Relative Strength of Acid

The strength of an acid depends on its ability to transfer its proton (H^+) to a base to form its conjugate base.

$HA + H_2O \rightleftharpoons H_3O^+ + A^-$

Conjugate Base

$H_3O = H^+$

Therefore $HA + H_2O \rightleftharpoons H^+ + A^-$

Hence $K_a = \frac{[H^+][A^-]}{[HA]}$

Where K_a is a dissociation constant.

Step III: the researcher however explain the relative strength of a base as follows;

The relative strength of a base

According to the Arrhenius concept, a base is a substance which produces OH- ions in aqueous solution. The basic properties of such a substance are due to these hydroxyl ions.

$BOH \rightleftharpoons B^+ + OH^-$

$\therefore$

$K_b = \frac{[B^+][OH^-]}{[BOH]}$

K_b = base dissociation constant.

- **Step IV:** the researcher further define salts as follows:
  A salt is a compound formed when all or part of the ionizable hydrogen of an acid is replaced by metallic ammonium ions. Also a salt is an ionic compound which is made up of two groups of oppositely charged ions. The ion with a positive charge is called cation, and the one with a negative charge is called anion. A salt is a compound formed when all or part of the ionizable hydrogen of an acid is replaced by metallic ammonium ions.

Types of salts

There are five types of salts

- **Normal salt:**

Normal salt are formed when all the ionizable hydrogen ions in an acid have been completely replaced by metallic ions.

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

$H_2SO_{4\,(aq)} + ZnO_{(s)} \rightarrow ZnSO_{4\,(aq)} + H_2O_{(l)}$

Normal salts are neutral to litmus. However, a few normal salt such as Sodium trioxocarbonate (IV), Aluminum Chloride and Sodium Sulphide will undergo hydrolysis in water to give an acidic or alkaline solution or medium.

Acid Salts

They are formed when the replaceable hydrogen ions in acids are only partially replaced by a metal. They are produced by acids containing more than one replaceable hydrogen ion.

Acid salts result when there is an insufficient supply of metallic ions to replace all the replaceable hydrogen ions in the acids. For example,

$H_2SO_{4\ (aq)} + KOH \rightarrow KHSO_{4\ (aq)} + H_2O_{\ (l)}$

Basic Salts

It contains the hydroxide ion OH^-. They occur when there is insufficient supply of acid which is needed for the complete neutralization of the base. For example, basic salts have the properties of a base, it turns red litmus blue and will react with excess acid to form normal salt and water.

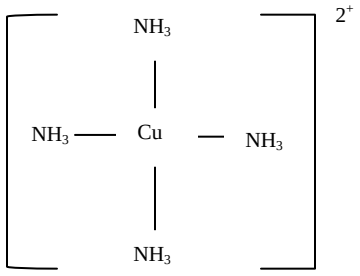
$Ca(OH)_{2\ (aq)} + HCl \rightarrow Ca(OH)Cl_{\ (aq)} + H_2O_{\ (l)}$

Double Salts

They are salts which ionize to produce three different types of ions in solution. Usually two of these are positively charged, while the other is negatively charged.

Complex Salts

They are salts formed by mixing together two simple salts. These salts are characterized by the formation of a new ion called complex ion which displays characteristics properties of its own both in the solid state and in aqueous solution. Example: In tetraamine Copper (II) ion. $[Cu(NH_3)_4]^{2+}$



Evaluation; the researcher evaluate the lesson by asking the following questions;

1. Define acids and bases
2. Mention some common acids and bases
3. Explain the relative strength of acid and base.

Summary: The researcher along with the students will highlight main points of the lesson and then give them the opportunity to ask questions if any.

Conclusion; by the end of the lesson, the researcher dictates the note to the students. Students will be asked to read on the next sub-topic which is the characteristics, preparations and uses of acids, bases and salts.

LESSON PLANS FO CONTROL GROUP
LESSON PLAN TWO
Subject: Chemistry
Topic: acids, bases and salts
Sub-topic: Basic Concepts: characteristics, proparties, and uses of acids and bases
Duration: 40 minutes
Class: SS II
Age; 15-16 years
Sex; Males and Females
Date:
Teaching Method: **Lecture method**
Instructional Materials: **new school chemistry textbook, chalk and chalkboard**
Objectives: By the end of the lesson, the students should be able to:

1. State the characteristics of acids and bases
2. State the different types of acid and bases
3. gives the uses of acids, bases

Previous Knowledge; Students have learnt the concept of acids and bases and their relative strength.
Introduction: the researcher introduces the lesson by revising the previous lesson to ensure better understanding of the students.

Presentation; the researcher presents the lesson through the following steps:
Step I: the researcher introduces the lesson by explaining the difference between strong acids and week acids as follows;
Strong Acids: they ionize completely in water to give hydrogen ions and anions. Such acids have high concentration of hydrogen ion. E.g.
Hydrochloric acid $HCl \rightarrow H^+ + Cl$
Trioxonitrate (v) acid $HNO_3 \rightarrow H^+ + NO_3^-$
Tetraoxosulphate (VI) acid $H_2SO_4 \rightarrow 2H^+ + SO_4^{2-}$
Weak acid: they only partially ionized in water. Such acids in solution have a low concentration of hydrogen ion. E.g.
Trioxocarbonate (IV) acid $H_2CO_3 \rightleftharpoons 2H^+ + CO_3^{2-}$
Tetraoxosulphate (V) acid $H_3PO_4 \rightleftharpoons 3H^+ + PO_4^{3-}$
Ethanoic acid $CH_3COOH \rightleftharpoons H^+ + CH3COO^-$

Step II: The researcher went further to list the physical properties of acids and bases as follows:
Acid have properties such as;
-sour taste
-they change blue litmus paper red,
-they are corrosive,
-release H2 when reacted with a more electropositive metal,
- they neutralizes base, etc.
Base have properties such as:
- they have bitter taste,

-They are soapy to the touch,
- Turn red litmus blue,
-they neutralizes acids
- The concentrated form of NaOH and KOH are corrosive.

Step III: The researcher went further to explain the chemical properties of acids and bases as follows:

Chemical properties of acids

Reaction with metals

Acids reacts with metals like Zinc, Iron and Magnesium to liberate Hydrogen gas.

Acid + Metal → Salt + Hydrogen

$2HCl + Zn \rightarrow ZnCl_{2\,(aq)} + H_{2\,(g)}$

$H_2SO_{4\,(aq)} + Mg_{\,(s)} \rightarrow MgSO_{4\,(aq)} + H_2$

Reaction with base

Acids react with insoluble bases to form salts and H_2O as the only end product. Such reaction is called neutralization.

Acids + Base → Salt + Water

$H_2SO_{4\,(aq)} + 2KOH_{\,(aq)} \rightarrow K_2SO_4 + 2H_2O_{\,(l)}$

Reaction with trioxocarbonates (IV)

Acid react with trioxocarbonate (IV) to give CO_2

$2HCl + Na_2CO_{3\,(aq)} \rightarrow 2NaCl + H_2O_{\,(l)} + CO_{2\,(g)}$

Chemical Properties of base

Reaction with acids

All base reacts with acids to form salt and water.

$MgO_{\,(s)} + 2HNO_{3\,(aq)} \rightarrow Mg(NO_3)_{2\,(aq)} + H_2O_{\,(l)}$

Reaction with Ammonium salts

They reacts with ammonium salts in the presence of heat to generate ammonia gas.

$Ca(OH)_{2\,(aq)} + 2NH_4Cl_{\,(aq)} \rightarrow CaCl_{2\,(aq)} + 2H_2O_{\,(l)} + 2NH_{3\,(g)}$

Step IV: the researcher further explain the uses of acid and bases to the students as follows:

Uses of acids

Acids are used in the production of fertilizers, detergents, drugs, in making of fruit juice, they are also used as drying agents, oxidizing agents and catalysts.

Uses of Alkalis (Base)

They are used in the manufacture of glass, soap, paper, rayon. Some alkalis are also used to soften hard water.

Evaluation; the researcher evaluate the lesson by asking the following questions;

1.Give the types of acids and bases
2.Mention some common properties of acids and bases
3.Give more examples of chemical equations indicating the acid and base.
4.List the uses of acid and bases.

Summary: The researcher along with the students will highlight main points of the lesson and then give them the opportunity to ask questions if any.

Conclusion; At the end of the lesson, the researcher dictates the note to the students. Students will be asked to read on the next sub-topic which is deliquescence, hygroscopic and efflorescence substances.

LESSON PLAN FOR COTROL GROUP
LESSON PLAN THREE

Subject: **Chemistry**
Topic: **acids, bases and salts**
Sub-topic: **Basic Concepts: Neutralization**
Duration: **40 minutes**
Class: **SS II**
Age: **15-16 years**
Sex: **Males and Females**
Date;
Teaching Method: **Teaching-With-Analogy (TWA) Strategy**
Instructional Materials; new school chemistry textbook, table salt, Sodium chloride.
Objectives: By the end of the lesson, the students should be able to:

4. Define neutralization
5. Explain the process of neutralization.
6. Write a neutralization reaction.

Previous Knowledge; Students have learnt about Acids and Bases and salts, and how to use litmus paper in testing Acids and Bases.

Introduction: the researcher introduces the lesson by revising the previous lesson to ensure better understanding of the students.

Presentation; the researcher presents the lesson through the following steps:

Step I: the researcher presents the lesson by defining neutralisationas follows:

Neutralization is a process in which an acid reacts completely with an appropriate amount of a base to produce salts and water only. Also neutralization is the combination of hydrogen ions, H^+, and hydroxide ions, HO^-, to form water molecules H_2O and salt.

- Although acids and bases have different chemistries, the acid and base cancel each others chemistry to produce a rather innocuous substance which is water. In fact the general reaction between an acid and a base is

  Acid + Base → water + Salt

  For example, the balanced chemical equation for the reaction between HCL(aq) and KOH(aq) is

  $$HCL_{(aq)} + KOH_{(aq)} \rightarrow H_2O_{(l)} + KCL_{(aq)}$$

Where the salt is KCL. By counting the number of atoms of each element, we find that only one water molecule is formed.

Step II: the researcher further give some examples of neutralization reaction, as:

i. $2HCL_{(aq)} + Mg(OH)_{2(aq)} \rightarrow 2H_2O_{(l)} + MgCL_{2(aq)}$

Here the salt is $MgCL_2$

ii. $2HOCL_{(aq)} + (Na)_2CO_{3(aq)} \rightarrow 3H_2O_{(l)} + 2NaCL_{(aq)}\, 2HCL_{(aq)} + CO2_{(g)}$

Evaluation; the researcher evaluate the lesson by asking the following questions;

iv. Define salt
v. Give the types and uses of salt
vi. Explain salt hydrolysis and give examples

Summary: The researcher along with the students will highlight main points of the lesson and then give them the opportunity to ask questions if any.

Conclusion; at the end of the lesson, the researcher write the note on the board for the students to copy.

LESSON PLAN FOR CONTROL GROUP
LESSON PLAN FOUR
Subject; Chemistry
Topic; acids, bases and salts
Sub-topic; Basic Concepts: deliquescent, Efflorescence and hygroscopic substances
Duration; 40 minutes
Class: SS II
Age: 15-16 years
Sex: Males and Females
Date:
Teaching Method; Lecture method
Instructional Materials; new school chemistry textbook,
Objectives; By the end of the lesson, the students should be able to:

1. Define efflorescence, deliquescence and hygroscopic substances
2. gives examples of efflorescence, deliquescence and hygroscopic substances
3. explain what are drying agents and desiccants

Previous Knowledge; Students have learnt the properties, types and reactions of acids and bases.
Introduction: the researcher introduces the lesson by revising the previous lesson to ensure better understanding of the students.

Presentation; the researcher presents the lesson through the following steps:

Step I: the researcher introduces the topic by defining deliquescence, efflorescence and hygroscopic substances as follows;
Deliquescent, efflorescent and hygroscopic Substances
There are certain compounds that are exposed to air, they either lose their water of crystallization or they absorb moisture from their surroundings. The terms efflorescent, deliquescent and hygroscopic are used to describe such compounds.
Efflorescence: Is the spontaneous loss of water by a hydrated salt, which occurs when the aqueous vapour pressure of the hydrate is greater than the partial pressure of the water vapour in the air.
Deliquescence: It is a process by which compound or substance absorbs moisture from the atmosphere so that they eventually turn into solution. Examples are:
Hygroscopic: They are substances that absorbs moisture from the exposure to the atmosphere.
Step II: The teacher give some examples of hygroscopic, efflorescence and deliquescence substances:
Examples of hygroscopic substances include:

- Sodium trioxonitrate (V)
- Copper (II) oxide
- Quicklime

Examples of deliquescence substances are:

- Sodium hydroxide
- Iron (III) Chloride

- Potassium hydroxide
- Calcium chloride
- Magnesium chloride
- Phosphorus (V) oxide

An example of efflorescence is the washing soda molecule which loses nine out of its ten molecules of water of crystallization when exposed to the atmosphere.

$Na_2CO_3.10H_2O_{(s)} \rightarrow Na_2CO_3H_2O_{(s)} + 9H_2O_{(l)}$

- Also $Na_2SO_4.10H_2O$ is also efflorescent.

Step III: the researcher further describes drying agents or desiccants below;

Drying agents or desiccants' are substances that have a strong affinity for moisture or water. They may be either hygroscopic or deliquescent. They are usually used to dry gases in the laboratory. They also commonly used in desiccators. A drying agent cannot be used if it reacts with the substance to be dried. For example concentrated tetraoxosulphate (VI) acid cannot be used to dry ammonia since they react to form ammonium tetraoxosulphate (VI).

$2NH_{3\ (g)} + H_2O \rightarrow (NH_4)_2SO_{4\ (aq)}$

Evaluation; the researcher evaluate the lesson by asking the following questions;

1. 1.Define ef**flo**rescence, deliquescence and hygroscopic substances.
2. 2.Give examples of ef**flo**rescence, deliquescence and hygroscopic substances
3. 3.Explain drying agents or desiccants.

Summary: The researcher along with the students will highlight main points of the lesson and then give them the opportunity to ask questions if any.

Conclusion; at the end of the lesson, the researcher dictates the note to the students. Students will be asked to read on the next sub-topic which is the PH scale.

LESSON PLAN FOR CONTROL GROUP
LESSON PLAN FIVE
Subject; Chemistry
Topic; acids, bases and salts
Sub-topic; Basic Concepts: PH Scale and Indicators
Duration; 40 minutes
Class; SS II
Age; 15-16 years
Sex; Males and Females
Date;
Teaching Method; Lecture method
Instructional Materials; new school chemistry textbook,
Objectives; By the end of the lesson, the students should be able to:

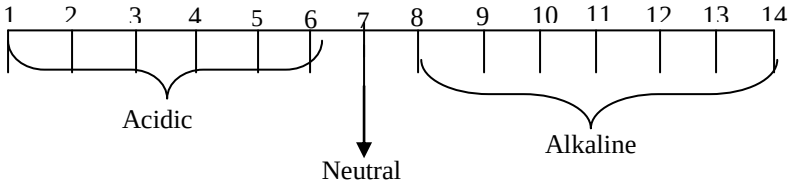
1. Explain the meaning of pH
2. State what indicators are
3. State the range of Acid and basic pH
4. State the indicators which are better for certain reaction.

Previous Knowledge; Students have learnt about Acids and Bases and how to use litmus paper in testing Acids and Bases.
Introduction: the researcher introduces the lesson by revising the previous lesson to ensure better understanding of the students.

Presentation; the researcher presents the lesson through the following steps:

Step I: the researcher introduces the lesson by defining the PH of a solution as follows;
The pH of a solution is a measure of hydrogen ions $[H^+]$ or hydroxonium ions $[H_3O^+]$ concentration of a solution which can be calculated as negative logarithms to base 10 of hydrogen ion $[H^+]$ concentration
$pH = - \log_{10}[H^+]$
Step II: The researcher explains how the PH is used as follows;
Generally pH scale extends from 1-14 and a pH of 7 is neutral; pH value less than 7 is Acidic while pH values greater than 7 to 14 is alkaline. Therefore the smaller the pH value, the more Acidic the solution while the higher the pH value, the more alkaline the solution. Pure water has a pH of 7 therefore it is neutral.

pH – Scale



Step III: researcher further explains indicators as weak organic acids and bases that changes colour depending on $[H^+]$ hydrogen or $[H_3O^+]$ hydroxonium ion concentration.

indicators are chemical substances which show different colours in different media. Indicators are weak organic Acids or bases that change colour depending on the hydrogen ion concentration (pH) of the solution. They are used in Acid base titration to detect the end point of a reaction and to test the Acidity or alkalinity of a solution.

Step IV: Teacher then give some groups Acids, others were given Alkali and some groups were given a neural solution. The teacher then gave the student litmus papers and different indicator and draws the table on the board.

Indicator	**Colour change in**		
	Acid	Neutral solution	Alkali
Methyl Orange	Pink	Orange	Yellow
Phenolphthalein	Colourless	Colourless	Pink
Litmus solution	Red	Purple	Blue

Step V: the researcher further explains to the students the choice of indicator since the accuracy of titration depends on the use of correct indicator therefore; a wrong choice of indicator usually leads to wrong end point.

Strong Acid Vs Strong base	HCl Vs NaOH	7.0	Any suitable indicator methyl orange phenolphthalein
Strong Acid Vs Weak base	H_2SO_4 Vs Na_2CO_3	5-6	Methyl orange
Weak Acid Vs Strong base	$H_2C_2O_4$ Vs NaOH	8-9	Phenolphthalein
Weak Acid Vs Weak base	CH_3COOH Vs NH_4OH	Variable	No suitable indicator

Evaluation; the researcher evaluate the lesson by asking the following questions;

1.Explain the meaning of PH

2.State the range of acid and basic PH

3.What are indicators?

Summary: The researcher along with the students will highlight main points of the lesson and then give them the opportunity to ask questions if any.

Conclusion; at the end of the lesson, the researcher dictates the note to the students. Students will be asked to read on the next sub-topic which is salt hydrolysis.