INFLUENCE OF CONCEPTUAL INSTRUCTIONAL METHOD ON STUDENTS' PERFORMANCE IN, AND ATTITUDE TOWARDS PRACTICAL CHEMISTRY AMONG STUDENTS IN KADUNA STATE, NIGERIA

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DECLARATION

I declare that, the work in this dissertation entitled "Influence of Conceptual Instructional Method on Students' Performance in, and Attitude Towards Practical Chemistry in Zaria Educational Zone of Kaduna State Nigeria" has been carried out by me in the department of science education. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this dissertation was previously presented for another degree or diploma at this or any other institution.

Binta Asabe **MUHAMMAD** _____ _____

Signature Date

CERTIFICATION

This dissertation, entitled: **"**INFLUENCE OF CONCEPTUAL INSTRUCTIONAL METHOD ON STUDENTS' PERFORMANCE IN, AND ATTITUDE TOWARDS PRACTICAL CHEMISTRY AMONG STUDENTS IN KADUNA STATE, NIGERI**"** by Binta Asabe MUHAMMAD (Ph.D /Educ./04868/2008-2009) meets the regulations governing the award of the degree of doctor of Philosophy (Ph.D) in science education of the Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

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TABLE OF CONTENTS

Title Page- - - - - - - - - - i

Declaration - - - - - - - - - - ii

Certification - - - - - - - - - - iii

Acknowledgment - - - - - - - - - - iv

Dedication - - - - - - - - - - vi

Table of Contents - - - - - - - - - vii

List of Figures - - - - - - - - - x

List of Tables - - - - - - - - - - xi

List of Appendices - - - - - - - - - xiii

Abbreviations - - - - - - - - - - xiv

Operational Definition of Terms - - - - - - - - xv

Abstract - - - - - - - - - - xvi

CHAPTER ONE: THE PROBLEM

1.1 Introduction - - - - - - - - - 1

1.1.1 Theoretical Framework - - - - - - - - - 9

1.2 Statement of the Problem - - - - - - - - 13

1.3 Objectives of the Study - - - - - - - - 15

1.4 Research Questions - - - - - - - - - 15

1.5 Null Hypotheses - - - - - - - - - - 16

1.6 Significance of the Study - - - - - - - - 17

1.7 Delimitation of the Study - - - - - - - - 18

1.8 Basic Assumptions - - - - - - - - - 19

CHAPTER TWO: REVIEW OF LITERATURE

2.1 Introduction - - - - - - - - - - - 20

2.2 Instructional Strategies for Teaching Science - - - - - 20

2.3 Conceptual Instructional Strategy - - - - - 21

2.3.1 Concept Acquisition - - - - - - - - - 23

2.3.2 Concept Teaching - - - - - - - - - - 24

2.3.3 Problems of Concept Learning - - - - - - - 26

2.4 Models and Theories of Concept Learning - - - - - 27

2.5 Practical Activities in Science - - - - - - - - 34

2.5.1 The Role of Laboratory-Activity in Practical Class - - - - - 39

2.5.2 Problem of Teaching Practical Chemistry at Secondary School - - - 41

2.5.3 Chemistry Practical Skills - - - - - - - 44

2.6 Instructional Strategies and Students Attitude in Science - - - 46

2.7 Students' Attitude and Academic Achievement in Science - - - 47

2.8 Gender Difference and Academic Performance in Science - - - 50

2.9 Overview of Similar Studies - - - - - - - 52

2.10 Implication of Literature Reviewd on the Present Studies - - - 56

CHAPTER THREE: METHODOLOGY

3.1 Introduction - - - - - - - - - 58

3.2 Research Design - - - - - - - - 59

3.3 Population of the Study - - - - - - - 60

3.4 Sample and Sampling Procedure - - - - - - - 62

3.5 Instrumentation - - - - - - - - 64

3.5.1 Chemistry Practical Achievement Test - - - - - - 64

3.5.2 Chemistry Practical Performance Test - - - - - 65

3.5.3 Chemistry Practical Attitude Inventory - - - - - - 66

3.5.4 Validation of the Instruments - - - - - - 67

3.5.5 Pilot Study - - - - - - - - - 68

3.5.6 Items Characteristics of the Instruments - - - - - 69

3.5.7 Items Difficulty Index - - - - - - - 69

3.5.8 Items Discrimination Index - - - - - - - - - 70

3.5.9 Reliability of the Instruments - - - - - - - 71
3.6 Data Collection Procedure - - - - - - - 71
3.6.1 Pretest Administration - - - - - - - - - 71
3.6.2 Administration of the Treatment to the Subjects in the Experimental group - 72
3.6.3 Administration of the Treatment to the Subjects in the Control group - 74
3.6.4 Procedure for Data Collection - - - - - - - 74
3.7 Procedure for Data Analysis - - - - - - - 75

CHAPTER FOUR :DATA ANALYSIS, RESULTS AND DISCUSSION

4.1 Introduction - - - - - - - - - 77
4.2 Data analysis and Results - - - - - - - 78
Null Hypothesis 1 - - - - - - - - - 78
Null Hypothesis 2 - - - - - - - - - 80
Null Hypothesis 3 - - - - - - - - - 82
Null Hypothesis 4 - - - - - - - - - 83
Null Hypothesis 5 - - - - - - - - - 84
Null Hypothesis 6 - - - - - - - - - 86
4.3 Summary of Findings - - - - - - - - 87
4.4 Discussion of Results - - - - - - - - 88

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction - - - - - - - - - 94
5.2 Summary of the Study - - - - - - - 94
5.3 Summary of Major Findings - - - - - - - 96
5.4 Conclusions - - - - - - - - - 97
5.5 Recommendations - - - - - - - - 97
5.6 Contribution to Knowledge- - - - - - - - 98
5.7 Limitations of the Study - - - - - - - 99
5.8 Suggestions for Further studies - - - - - - 99
References - - - - - - - - - - 100
Appendices - - - - - - - - - - 113

LIST OF FIGURES

Figure

2.1 Practical Work Linking two Domains of Knowledge- - - - 37

3.1 Research Design Illustrations - - - - - - - 59

3.2 A Flow Chart of Tennyson and Cocchiarella Model of Concept Teaching - 73

List of Tables

Table

1.1 Kaduna State Students Performance in Chemistry at (2004- 2012) - - 4

2.1 Different Types of Chemical Experimentation - - - - 36

3.1 Population of the Study - - - - - - - 61

3.2 Constitution of the Study Sample - - - - - - 62

4.1 Academic Achievement Posttest mean Scores of Subjects in the Experimental and Control group - - - - - - - - 78

4.2 Comparison of Academic Achievement Posttest mean Scores of the Subjects in Subjects in the Experimental and Control group - - - - 79

4.3 Academic Achievement posttest mean Scores of Male and Female Subjects in the Experimental group - - - - - - - - 80

4.4 Comparison of Academic Achievement posttest mean Scores of Male and Female Subjects in the Experimental group - - - - - - 80

4.5 Practical Performance of the Posttest mean Scores of the Subjects in the Experimental and Control group - - - - - - 81

4.6 Comparison of Practical Performance of the Posttest mean Scores of Subjects in the Experimental and Control group - - - - - -` 82

4.7 Practical Performance of the Posttest mean Scores of Male and Female Subjects in the Experimental group - - - - - - - - 83

4.8 Comparison of Practical Performance of the Posttest mean Scores of Male and Female Subjects in the Experimental Group. - - - - - - 83

4.9 Attitude Change of Subjects in the Experimental Group - - - 84

4.10 Comparison of the Attitude Change of the Subjects Taught Using Conceptual Instructional Method - - - - - - - - 85

4.11 Relationship Between Academic Achievement and Practical Performance Scores of the Subjects in the Experimental Group. - - - - - 86

4.12 Comparison of the Relationship Between Academic Achievement and Practical Performance Scores of the Subjects in the Experimental Group. - - - 86

LIST OF APPENDICES

Appendix:

1. Chemistry Practical Achievement Test (CPAT) - - - - 113
2. Marking Guide for (CPAT) - - - - - - - 115
3. Chemistry Practical Performance Test (CPPT) - - - - 119
4. Chemistry Practical Attitude Inventory (CPAI) - - - - 121
5. Validations of the Research Instruments - - - - - 123
6. Reliability of the Instruments - - - - - - - 127
7. *t*-tes of the Pretest Means Scores of the Experimental and the Control Groups 130
8. Lesson Plan for the Experimental Group - - - - - 131
9. Lesson Plan for the Control Group - - - - - - 158
10. Analysis of Posttest Mean Scores - - - - - - 166
11. Communication on this Study- - - - - - - 171

Abbreviations

In the cause of this study, some words have been abbreviated and frequently used in the text The abbreviated words are outlined as follows:

- CPAT - Chemistry Practical Achievement Test
- CPPT - Chemistry Practical Performance Test
- CPAQ - Chemistry Practical Attitude Questionnaire
- CPAI - Chemistry Practical Attitude Inventory
- N.E.R.D.C . - National educational Research and Development Council
- F.R.N - Federal Republic of Nigeria
- LAQ - Learning Approach Questionnaire
- AAAS - American Association for the Advancement of Science
- EG - Experimental group
- CG - Control group
- WAEC - West African Examination Council
- NECO - National Examination Council
- SSCE - Senior School Certificate Examination
- L.G.A - Local Government Area
- G.S.S - Government Secondary School
- STAN - Science Teachers Association of Nigeria
- N.T.I. - National Teachers Institute

Operational Definition of Terms

Conceptual Instructional Method: Is a type of instruction, where emphasis is placed on teaching the concepts in the subject. It leads to increase in conceptual understanding and ability to respond to common features or categories of objects or events.

Attitude: A relatively enduring organization of beliefs, feelings, and behavioral tendencies towards socially significant objects, groups, events or symbols. It is a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor.

Constructivism: This theoretical framework holds that learning always builds upon knowledge that a student already knows; this prior knowledge is called a schema. The teaching is based on the belief that learning occurs as learners are actively involved in a process of meaning and knowledge construction as opposed to passively receiving information. Learners are the makers of meaning and knowledge.

Achievement: Is the outcome of education the extent to which a student, teacher or institution has achieved their educational goals usually weighted as a score.

Instructional method: Is an educational approach for turning knowledge into learning. Instructional methods are the "how to" in the delivery of training. The methods used in any learning situation are primarily dictated by the learning objectives decided upon by the course developers. In many cases a combination of methods are used to intensify the learning experiences.

Practical performance: It is the use of knowledge and skills students have learnt during class to complete tasks and with confidence solve practical tasks and take responsibilities

Abstract

Researches in chemistry education have shown that students' low performance in practical chemistry was due to lack of in-depth conceptual understanding of chemical concepts behind practical chemistry. It was based on this that, the study investigated the Influence of Conceptual Instructional Method on students' Performance in, and Attitude towards Practical Chemistry in Zaria Educational Zone, Kaduna State. The target population for the study was 1401 S.S. II Science Students. The subjects in the coeducational schools were pretested and schools that do not differ significantly were chosen for the study. A sample of 100 Students was randomly drawn from two co-educational senior secondary schools, within Zaria educational zone. The subjects were divided in to two groups: The experimental group and the control group of 50 students each. The pretest-posttest quasi-experimental control group design was adapted. The subjects in the experimental group were exposed to Conceptual Instructional Method, while those in the Control group were exposed to the lecture instructional strategy for a period of six weeks. The following instruments were developed and validated for data collection: Chemistry Practical Achievement Test (CPAT) with reliability coefficient of 0.71, Chemistry Practical Performance (CPPT) with reliability coefficient of 0.73 and Chemistry Practical Attitude Inventory (CPAI) with reliability coefficient of 0.79. Six research questions were stated and six null hypotheses were tested. The data collected were subjected to statistical analysis at 0.05 level of significance. *t*-test statistics was used to test the hypotheses on achievement, performance and gender difference. Mann-Whitney *U*-test was used to test the subjects change in attitude towards practical chemistry while Pearson product moment correlation coefficient *r*- statistic was used to test the relationship between academic achievement and practical performance of subjects in the experimental group. The major findings from the study include the following: The Academic Achievement, Practical Performance and Attitude of Subjects Exposed to Conceptual

Instructional Method were significantly higher than their counterparts exposed to lecture method of instruction. With reference to gender, there was no significant difference between male and female students academic achievement in the experimental group but, there was a significant difference between male and female students practical performance with the male students performing better than their female counterparts. It was also found that, there was a significant relationship between academic achievement and practical performance of subjects in the experimental group. On the basis of the findings outlined above, it was concluded that, conceptual instructional method enhances senior secondary school students' academic achievement, practical performance and attitude towards practical chemistry. A number of recommendations were made some of which are as follows: (1) Chemistry teachers should incorporate conceptual instructional method for teaching at senior secondary school level. (2) Curriculum planners should recommend and ensure conceptual instructional method is used for teaching chemistry at senior secondary school.

CHAPTER ONE

THE PROBLEM

1.1 Introduction

Science educators have been advocating the need for science instruction at all levels to focus on enhancing students conceptual understanding, higher levels of performance in scientific thinking, reasoning and problem solving (Gabel, 2003; Chin & Chia, 2005). This advocacy is inconsistent with various reform initiatives around the globe, for both science and mathematics curricula and classroom practices. For instance, the need to develop students' conceptual understanding and scientific literacy by using inquiry and problem-solving experiences and skills acquisition has been emphasized in the United States reform documents of the American Association for the Advancement of Science (AAAS, 2005; 2008) and National Research Council N.R.C. (2007).

Numerous countries, notably South Africa and Ghana, have directly or indirectly shared the notion of educating all their citizens in science and technology through inquiry and problem solving as a major part of their educational reforms (Abdelkhalick, Boujuade, Duschl, Mamlok-Naaman, Hofstein, Niaz, Treaquest & Tuan 2004). The ultimate aims of teaching science in every society is to provide people with the knowledge of science needed for the fulfilment of the socio-economic and cultural needs of the society (Jegede, 2010). The Federal Government of Nigeria seems to have realized the importance of science education as an important key for development by stating in its National Policy on Education that the goals of science shall be "to cultivate inquiring, knowing and rational mind for the conduct of a good life and democracy" among other goals (FRN, 2007,Pp 13). This is in realization of the strength of inquiry in enhancing conceptual understanding in science.

The role of chemistry in the development of the scientific base of a country cannot be over-emphasized, and Nigeria is not an exception (Oloyede, 2010) chemistry is one of the science subjects taught at the senior secondary school level. It is one of the core science subjects that students are required to pass in order to qualify for admission into tertiary institutions to pursue science-based programmes such as Medicine, Engineering, Pharmacy, among others (Shaibu, 1998; Njoku, 2007; Oloyede 2010).

Chemistry is an experimental science which relies primarily on the harmony between theory and practice. It should therefore be taught as such. It follows, therefore, that understanding of a concept in practical chemistry assists in enhancing students' understanding of chemistry (Ikeobi, 2010). Students have difficulty in making connections between the sub-disciplines of chemistry (which tend to be taught separately); the link between practical work and theoretical concepts is often less than obvious; not enough emphasis is given to understanding of concepts in practical chemistry (Cole, Janes, Mclean &Nicholas, 1998). According to Muhammad (2007), chemistry students who have inadequate practical knowledge find it difficult to cope with some aspects of the course, which is an indication that understanding of theoretical concepts affects understanding of the practical aspects. In chemistry teaching, the importance of harmonizing practical work with theoretical bases cannot be over-emphasized. Omolade (2008) states that, if the performance of students is to be enhanced, learners must have deep understanding of basic concepts behind practical task they engage in. This is because the observations and experiments students carry out are meant to confirm some theories and the application of concepts.

In spite of this important position of chemistry among other science and science-related disciplines, students' academic performance has consistently been below expectation and unimpressive (Akinleye, 1987; Adeniyi & Landu, 1997; Njoku, 2005; Jegede, 2010 & Oloyede, 2010). Activities by professional bodies, like Science Teachers Association of

Nigeria (STAN) for the past two decades have been aimed at stimulating interest in science at all levels of education. Chemistry aspects that have been looked into include curriculum modification and innovation, teaching methods, teaching facilities and students' factors. Perhaps, one factor that has not received much attention is the role of conceptual instruction in popularizing science (Jegede, 2010). In spite of the emphasis and attempts at the modification of curriculum, its desired level of improvement remains an illusion.

Several researchers indicate that chemistry is regarded as an abstract and difficult subject to learn by many students (Tami, Avi, Racheal & Ziva, 2004; Onder & Geban, 2006; Abuzer, 2009). Chemistry is one of the physical sciences that is affected by high level of underachievement by learners. The performance of students in science reflects how well they understand science concepts and is a reflection of how good the instruction is (Jegede, 1996). The performances of chemistry students in Kaduna State have been declining over the years (2004-2012) as shown in the Table 1.1

Table 1.1 Kaduna State Students' Performance in Chemistry at WAEC, MAY/JUNE 2004 -2012

CHEMISTRY	% OF PASSES AT CREDIT LEVEL
2004	37.86
2005	40.94
2006	44.90
2007	18.40
2008	36.52
2009	39.45
2010	43.42
2011	18.50
2012	19.00

Source: WAEC Chief Examiner's Report, (2004 – 2012)

The need to find a solution to students' low performance is, therefore, obvious. According to Ekejiafor (1993), Damide (2000), Oloyede (2008) and Zayun (2008), several factors have been advanced for the low performance of students in chemistry. These include: teaching and learning materials, mathematical nature of chemistry concepts and laws, language problem, student factor, teacher factor, societal factor and instructional strategies employed by teachers among others. However, Akinleye (1987), Njoku (2007) and Oloyede (2008) observe that students' low performance in the practical aspect of the subject contributes substantially to failure rate in 'O' Level chemistry. The West African Examinations Council (WAEC, 2007) Chief Examiners' report shows that students' performances are generally low in practical chemistry.

There is no doubt that senior secondary school students have difficulties in performing chemistry practical activities due to lack of conceptual knowledge and, apart from that, in most of the science senior secondary schools, there is no specific time allocated for practical chemistry as observed in general time-tables in most of the schools (Musa, 2000). Bugaje (2010) states that lack of conceptual knowledge usually affects students' academic achievement adversely as the learners memorises contents which they cannot provide conceptual link nor can they effectively apply them to solve problems they are confronted with during practical exercises. Many educators continue to ponder on the methods that could be adopted to improve the conceptual understanding of concepts in chemistry.

A review of past SSCE (WAEC, 2005, 2007, 2008 & 2009) chemistry practical examination papers shows that there are usually three questions. Question one is usually quantitative chemical analysis involving acid-base titrations and computation of known variables using the data generated. Question two is qualitative chemical analysis involving identification of given chemical substances through analysis of their constituent ions and/or

functional groups. Question three is theory of practical which requires cognitive understanding of basic concepts that underlie chemistry practical activities. Njoku (2007) found that students had the lowest score in theoretical concepts of practical chemistry. He therefore recommended that the theoretical concepts of practical chemistry should be taught to students before the commencement of the practical. Lee and Fraser (2001) also notice that the harmony between practical chemistry and theoretical aspects was often less than obvious; not enough emphasis was given to the theoretical aspects of practical chemistry. Therefore there is the need to teach students the concepts in practical chemistry to see whether it would enhance their performance.

Research in chemistry education has continued to seek for better approaches for teaching chemistry in order to bring about meaningful learning and to identify factors responsible for low conceptual understanding in practical chemistry among students (Wu, Krijcik & Soloway, 2000; Onwu, 2002; Erlis & Subramanian, 2004). Research findings have revealed that to date a large proportion of science teachers, chemistry inclusive, still resort to the use of conventional methods such as lecture and demonstration methods rather than activity-oriented strategies (Betiku, 2002; Muhammad, 2007; Oloyede, 2010). A number of science education researchers have been concerned with developing ways of facilitating students' understanding of concepts which are fundamental to the understanding of science (Gobinath, 2001; Okebukola, 2002; Palmer, 2002).

Conceptual knowledge is the knowledge rich in relationships and understanding. It is a connected web of knowledge, a network in which the linking relationships are as prominent as the discrete bits of information. Conceptual knowledge cannot be gained by rote learning. It must be learnt by thoughtful, reflective learning. In general there are three different forms of conceptual knowledge which are distinguished as:

1. Motor-movements to perform specific actions
2. Mental imaginary; the perception of state of affairs or entities is re-experienced in the mind.
3. Symbolic form: information is stored or manipulated (e.g By thinking) using some inner language symbolizing concepts (Rittle, 2009).

Conceptual knowledge or "semantic memory" understands the concepts in order to solve problems (so students may use any procedures). A great example is with stoichiometry calculation of mole concepts in practical chemistry. Many students can solve some practical problems for a test because they memorized a procedure only, but they forget after about two weeks later. Thus, the students have not mastered the conceptual knowledge. Finally conceptual knowledge is the knowledge of classifications, principles, generalizations, theories, models or structures pertinent to a particular disciplinary area. It refers to a person's representations of major concepts (Howard-Jones & Matin, 2002). Conceptual instructional method is a type of instruction where emphasis is placed on teaching the concepts in the subject to be taught using appropriate instructional strategies (Gobinath, 2001). It leads to increased conceptual understanding and transfer of correct procedures (Alibali, 1999). Concept formation or concept learning is referred to as the development of the ability to respond to common features or categories of objects or events. Concepts are mental categories or objects, events or ideas that have a common set of features (Howard & Matin, 2002).

Ibrahim, Erdal and Mustapha (2009) states that; Conceptual instructional method is a process of acquiring a better understanding of concepts. According to Webster (2006); teaching students the basic concepts behind problems was more useful than teaching students procedure for solving the problems, as this enhance and elicits better explanation and make learners learn more, since students must understand concepts before they can be able to solve

problems. Rittle (2009) states that; good conceptual knowledge can aid problem solving and enhance academic achievement in practical chemistry. The present study is aimed at also investigating students attitude towards practical chemistry. Students' attitude towards a subject affects their understanding of the subject (Timothy, 2006). Therefore when students have positive attitude towards practical chemistry it will enhance good conceptual understanding of the concepts being taught.

Erkus (2003) says that teachers realize the importance of how students feel about science subjects and courses; nevertheless they place little emphasis on affective objectives. The affective domain is often neglected because teachers have difficulty in designing strategies to develop positive attitude among student and documenting their development (Thomas & Kobella, 2002). However, students' achievement also depends on attitudes that allow them to participate in and ultimately benefit from academic instruction in classroom (Liza, 2010).

Students' attitude (opinion or general feeling) towards practical chemistry need to be assessed during the lesson so that the teacher can know how the students feel towards the teaching strategies, classroom activities and the subject matter. This will assist the teacher by providing effective basis for developing useful educational innovations to facilitate chemistry learning (Muhammad, 2007). It was found by Adesokan (2000) who states that; students still show negative attitude towards chemistry among the science subjects in spite of the recognition given to the subject, thus leading to poor performance and low enrolment.

Since the teaching strategy employed by teachers influences the attitude of students towards a subject, learners who are taught meaningfully have good grasp of concepts which is expected to enhance their performance and thus motivate them to develop positive attitude towards the subject. Conceptual instruction has the potential to increase meaningful learning of concepts, and could have positive effects on students attitude towards practical chemistry at senior

secondary school level. Ajzen and Fishbein (1980), Erkus (2003) and Jaynes (2005) also observe that changing attitudes does not require treatments lasting weeks or months; attitudes can be changed in a short time provided that attention is paid to the variables harboured within the question. The study determines the effects of conceptual instructional method within the period of students exposure to instructional mode

The influence of gender on students' performance has for a long time been of concern to many researchers, but no consistent results has been established. For instance, Inyang and Jegede (1991), Okeke (2001) and Aluko (2005) report that gender has no effect on students' achievement in science. Shaibu and Mari (1997) and Lawal (2009) explained that female subjects were significantly better than their male counterparts and that there was a significant difference between the male and female subjects in their ability to solve quantitative problems. Some instructional strategies are gender-bias, while some are gender friendly; however, the degree of gender-related differences in learning vary from one method of instruction to the other. Therefore, the effects of conceptual instructional method on students' academic achievement and gender differences were determined in this study.

1.1.1 Theoretical Framework

The theoretical framework of this study was based on constructivism, which is basically a theory of observation and scientific study about how people learn. It says that people construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences. When students encounter something new, they have to reconcile it with their previous ideas and experience, maybe changing what they believe, or discarding the new information as irrelevant. In any case, they are active creators of their own knowledge. To do this, they must ask questions and explore what they know. In the most general sense, it usually means encouraging students to use active techniques to

create more knowledge and then to reflect on and talk about what they are doing and how their understanding is changing (Mustafa, 2008). The teacher makes sure he understands the students' pre-existing conceptions, and guides the activity to address them, and then builds on them. The theory attempts to give an explanation to how meaningful learning is achieved. The instructional mode is based on constructivism as it's proponent believe students can only understand concepts when they construct their own explanation of concepts as they participate in learning tasks.

Ausubel (1960) states that learning of new knowledge relies on what is already known. That is, construction of knowledge begins with our observation and recognition of events and objects through concepts we already have. We learn by constructing a network of concepts and adding to them. Ausubel also stresses the importance of reception rather than discovery learning, and meaningful rather than rote learning. He declares that his theory applies only to reception learning in school settings. Ausubel's (1968) learning theory is built around the concept of subsumption. When a new idea enters consciousness, it is processed and classified under one or more of the inclusive concepts already existing in the learner's cognitive structure. He also believes that, new meaningful material becomes incorporated into cognitive structure in so far as it is subsumable under relevant existing concepts. Subsumers provide a basic structure around which information is organized. They are the intellectual linchpins holding the system together.

Ausubel (1968) proposed the subsumption model of learning which was based on prior knowledge and was used for interpretation of new information to be learned. Thus he proposed the idea that meaningful learning takes place only when a general subsuming concept is available in learners' cognitive structure and that such idiosyncratic concepts are usually derived from currently held concepts. Ausubel, asserts that, for any meaningful learning to take place new materials to be learnt must be carefully linked to the learners' prior

knowledge, otherwise, rote learning would take place. Ausubel's idea has been utilized by some science education researchers e.g. Zuzovsky (1994) and the importance of the great ideas of Ausubel was revealed.

According to Ausubels' (1978) model of learning, the requisite advance organizer can be used when no anchoring idea are available to the learners, that is when new learning material is unfamiliar, to the learner which is phase one. In phase two, the presentation of learning task or materials make the organization of the new materials explicit; and finally phase three is the strengthening of cognitive organization that relates new information to advance organizer and promotes active reception of learning.

Table 1.2 Ausubel's Model of Learning

Phase One: Advance Organizer	**Phase Two: Presentation of Learning Task or Material**	**Phase three: Strengthening Cognitive Organization**
	Make the organization of the new material explicit.	Relate new information to advance organizer
Clarify aim of the lesson	Make logical order of learning material explicit.	Promote active reception learning
Present the organizer	Present material and engage students in meaningful learning activities.	
Relate organizer to students' knowledge		

*Source: Ausubel (1978)

Conceptual instructional method allows meaningful learning of concepts where students can use the knowledge learnt to solve both applied and direct questions which is unlike the factual knowledge that leads to rote learning. Conceptual instructional method promotes meaningful learning of concepts through elaborate links that ensure that concepts are explicitly understood and can then serve as anchor for further learning which can be applied to solve problems. Therefore, using conceptual instructional method to teach practical chemistry provides students with meaningful conceptual knowledge. Students, who come to the practical chemistry with prior knowledge of concepts behind practical skills to be learnt, tend to relate the learnt materials with their previous knowledge and are expected to be organized, focused and able to make relevant observations and conclusions. Concept teaching has to be carefully planned to go from simple concrete-concepts to complex concepts. Tennyson and Cocchiarella (1986) suggested a model for concept teaching that has three stages

(a) Establishing a connection in memory between the concept to be learned and existing knowledge.

(b) Improving the formation of concepts in terms of relations and

(c) Facilitating the development of classification rules.

This model acknowledges the declarative and procedural aspect of cognition. Concepts can be thought of, not as a list, but as a distribution of properties, some more central or typical of others.

Based on this notion, Tennyson and Cocchiarella (1986) model of concepts teaching was used for the study due to the fact that it lays emphasis on the use of students' prior knowledge to provide links with learning materials to aid the formation and development of concepts and relationships. It is vital to provide concrete evidence to back-up the fact that acquisition of theoretical concepts that serve as prior knowledge for learning practical

chemistry will enhance performance as suggested by Ausubel. In this study conceptual instructional method was used to teach students the theoretical concepts in practical chemistry. The theoretical framework of this study was therefore based on Ausubels' theory of prior knowledge of teaching/learning of concepts.

1.2 Statement of the Problem

Research in chemistry education has continued to seek better approaches for teaching practical chemistry in order to bring about meaningful learning and to identify factors responsible for persistent problems of low conceptual understanding among students. (Wu, Krijcik & Soloway, 2000; Onwu, 2002; Erlis, Subrama & Nian, 2004). Njoku (2007) conducted a research where he compared students' achievement in the three categories of questions i.e (Qualitative chemical analysis, quantitative chemical analysis and theory of practical) in senior secondary school certificate (S.S.C.E.) practical chemistry examination. Njoku found that students scored the highest mark in quantitative chemical analysis and the lowest mark in theory of practical aspect of the examination. Njoku inferred that students' low performance was due to lack of in-depth conceptual understanding of chemical concepts behind practical chemistry. Njoku further stressed that if teachers taught concepts upon which practical were based, performance in practical chemistry might be greatly enhanced.

Njoku (2007) then recommended the development of theoretical background knowledge of concepts upon which the practical activities would be based. Musa (2000) and Bugaje (2010) conducted similar researches and found that students performed poorly in the theoretical aspects of practical chemistry. This postulation seems to suggest that acquisition of concepts behind practical chemistry could serve as prior knowledge to provide meaningful links for learners to participate and maximally acquire knowledge and skills in practical chemistry. Provision of such learning opportunity is expected to enhance performance in

theoretical and practical chemistry. It was based on this recommendation that this study exposed students to the concepts in practical chemistry to find out whether it would enhance their performance. Practical work is, nonetheless, necessary for developing students' understanding of scientific concepts and explanations.

The role of practical work then in the teaching and learning of chemistry content is to help students' make links between two domains of knowledge (cognitive & psychomotor) and most students lack the understanding of practical chemistry concepts (Milar, 2004). It has been noted that students form negative attitude towards practical activities (N. R. C., 2002; Janyes, 2005; Situ, 2008). When students learn concepts meaningfully, they show positive attitudes towards the subject (Dana, 1990). With conceptual instructions, concepts appear less abstract resulting in students' change of attitudes towards practical chemistry. It was on this basis that students attitude towards practical chemistry was investigated to find out whether exposure of students to conceptual instructional method would affect their attitude. In addition, gender-related differences were investigated as it relates to the effect of conceptual instructional method on students' academic achievement and performance towards practical chemistry. So far, the question of how students' performance in practical chemistry can be enhanced is still a pedagogical problem.

1.3 Objectives of the Study

The following objectives were set for the study namely to:-

1. determine students' academic achievement of concepts in practical chemistry after exposure to conceptual instructional method.
2. find out whether there is any difference in academic achievement between male and female students exposed to conceptual instructional method.
3. determine whether exposure of students to conceptual instruction will enhance their practical performance in practical chemistry.
4. find out whether there is any difference in the practical performance between male and female students exposed to conceptual instructional method.
5. investigate the relative effectiveness of conceptual instructional method approach on students' attitude towards practical chemistry.
6. find out whether there is any relationship between academic achievement and practical performance of students exposed to conceptual instructional method.

1.4 Research Questions

This study seeks to answer the following research questions:

1) what is the difference in academic achievement between subjects taught practical chemistry concepts using conceptual instructional method and those taught the same concepts using the lecture method at senior secondary school level?
2) is there any difference in academic achievement between male and female subjects taught practical chemistry concepts using conceptual instructional method at senior secondary school level?

3) to what extent does practical performance of subjects taught practical chemistry concepts using conceptual instructional method differ from those taught the same concepts using lecture method at senior secondary school level?
4) is there any difference in the practical performance between male and female subjects taught practical chemistry concepts using conceptual instructional method at senior secondary school level?
5) what is the difference in attitude change of subjects taught practical chemistry concepts using conceptual instructional method and those taught using lecture method?
6) is there any relationship between academic achievement and practical performance of subjects taught practical chemistry concepts using conceptual instructional method?

1.5 Null Hypotheses

Ho_1: There is no significant difference in academic achievement between subjects taught practical chemistry concepts using conceptual instructional method and those taught same concepts using lecture method at senior secondary school level.

Ho_2: There is no significant difference in academic achievement between male and female subjects after exposure to practical chemistry concepts using conceptual instructional method at senior secondary school level.

Ho_3: There is no significant difference in practical performance of subjects taught practical chemistry concepts using conceptual instructional method and those taught the same concepts using lecture method.

Ho_4: There is no significant difference in practical performance between male and female subjects taught practical chemistry concepts using conceptual instructional method.

Ho_5: The difference in attitude change between subjects taught practical chemistry concepts using conceptual instructional method and those thought same concepts using lecture method is not significant.

Ho_6: There is no significant relationship between academic achievement and practical performance of subjects taught practical chemistry concepts using conceptual instructional method.

1.6 Significance of the Study

The findings of this study would hopefully uplift the standard of chemistry education in the following ways:

It would provide an insight on the effects of the mode of instructional methods on students' attitudes towards practical chemistry. Teachers could adopt the method to inculcate positive attitudes and motivate students to learn practical chemistry. The study also would aid teachers to design lessons that could enhance the learning of concepts in chemistry.

Model lessons on how to teach concepts was designed by the researcher which would serve as guide to teachers on how to design conceptual Instruction lessons. The study would also help science teachers to incorporate the approach into their existing teaching strategies. Moreover, the results of this study would be of immense benefits to both education planners and science curriculum planners who would recommend its use and also encourage teachers to acquire skills in designing and administering instruction via conceptual instructional method.

Also the study is expected to be beneficial to educational organizations such as Science Teachers Association of Nigeria (STAN), Association of Research and Development Council (NERDC), National Teachers Institute (NTI), National Association of Research in Science Education (NASER) among others, that carry out researches and organize

conferences, seminars and workshops for practicing science teachers on how conceptual instructional method could be effectively used to promote the teaching and learning of practical chemistry in schools. Finally, the study would provide the foundation for further research in the area of using conceptual instructional method in the teaching and learning of other chemistry concepts.

1.7 Delimitation of the Study

The study was delimited in the following ways:

The subjects involved in the study were S.S.II science students because S.S.I had not covered much of practical aspect of the syllabus and they were new in the subject while S.S.III students were preparing for their SSCE examination most of the students might not give the researcher the required attention. The subjects were in public senior secondary schools which included mixed and single-sex schools within Zaria Educational Zone of Kaduna State in the North-West geographical region of Nigeria. Zaria Educational Zone was chosen since it is an academic environment and Kaduna State is the central part of the Northern region, therefore there was proper representation and good generalization.

Practical aspect of chemistry was chosen for this study because of the mass failure of students in the practical chemistry examination (WAEC, Chief Examiners' report, 2007). The aspects of the practical involved in the study were theoretical concepts in qualitative and quantitative analysis where the failure rates of students had been observed (Musa, 2000; Njoku, 2007; Bugaje, 2010).

1.8 Basic Assumptions

This study had the following basic assumptions:

(i) Chemistry was taught by teachers who had the knowledge of practical chemistry

(ii) The subjects under study had been exposed to practical work in chemistry

(iii The selected topics were appropriate for the level of the subjects used for the study

(iv) The Conceptual Instructional Method and the Lecture Method used were appropriate for teaching the concepts in Practical Chemistry.

CHAPTER TWO

REVIEW OF LITERATURE

2.0 Introduction

In this study Influence of Conceptual Instructional Method on Students Academic Achievement and Attitude towards Practical Chemistry are Investigated. In this chapter, the literature relevant to the study was reviewed and presented under the following sub-headings:

2.1 Instructional Strategies for Teaching Science.

2.2 Conceptual Instructional Strategy.

2.3 Models and Theories of Concept Learning

2.4 Practical Activities in Science.

2.5 Instructional Strategies and Students Attitude in Science.

2.6 Attitude and Academic Achievement in Science.

2.7 Gender and Academic Performance in Science

2.8 Overview of Similar Studies

2.9 Implication of Literature Reviewed for the Present Study

2.2 Instructional Strategies for Teaching Science

Effective teaching and learning in any subject at any institution are dependent on the instructional strategies used and other variables Muhammad (2001). Instructional strategy is a major factor responsible for the level of performance in any subject by the students. Learning difficulties can be solved to a great extent by using appropriate teaching methods. Different approaches have been adopted for instruction in order to promote and direct learning. Teachers can impact knowledge by lecture method, team teaching method, demonstration method, discussion method, audio-visual instruction, activity method, tutoring method and integrated strategy method among others. (Bugaje, 2001).

Musa (2000) observes that one of the best ways for students to learn and remember concepts is to individually construct knowledge rather than to be lectured. There are several teaching methods which can be employed for teaching practical chemistry (Dan'Azumi, 2008). Prominent among the instructional methods used in teaching-learning are: Integrated strategies, laboratory method, discovery method, lecture method, demonstration method, field tripe and project methods. Integrated strategies will be employed for this study because no single method is adequate for proper conceptual understanding.

2. 3 Conceptual Instructional Strategy

Conceptual instruction is an art of conveying concept. It is designed to present an idea (Cambridge Advanced Learners' Dictionary, 3rd ed, 2009). Conceptual instruction is also known as category learning in which a human or machine learner is trained to classify object by being shown a set of example object along with their class labels. The learner will simplify what has been observed in an example. This simplified version of what has been learned will then be applied to future examples. Conceptual instructions range in simplicity and complexity because learning takes place over many areas. (Ratcliff, 2006).

Conceptual instruction assessment typically focused on a learners' ability to consider the nature of instances encountered based upon defining attribute belonging to the concept category (Bruner, Goodnow & Austin, 1966). The objectives of science at all levels are conceptual understanding (Gabel, 2003). Conceptual knowledge refers to a persons' representation of the major concepts in a system. It is also known as the kind of knowledge that may be transferred between situations. This is different from routine knowledge which is knowledge that is applicable only to certain situations (Webster, 2006).

Conceptual instruction leads to increased conceptual understanding (Alibali, 1999). Concept formation or concept learning is referred to as the development of the ability to respond to common features or categories of objects or events. Concepts are mental categories or objects, events or ideas that have a common set of features (Howard-Jones & Martin, 2002). Concept learning encompasses learning how to discriminate and categorize things (with critical attributes). It involves recall of instances, integration of new examples and sub-categorization. Concept formation is not related to simple recall, it must be constructed. Concepts can be thought of, not as a list, but as a distribution of properties, some more central or typical than others. The prototype is an abstraction of the central properties and need not correspond to any example (Palmer, 2002).

Research by Bethany (2009) from Verndabiit University has found that students benefit more from being taught the concepts behind math problems rather than the exact procedure to solve the problems. The finding offers teachers new insights in to how best to shape Math instruction to have the greatest impact on students learning (Bethany, 2009). Teaching students the basic concepts behind problems is more useful than teaching students procedures for solving the problems, these students gave better explanation and learn more (Webster, 2006).With conceptual instruction, teachers explain the basic concepts of problems underlying structure. That type of instruction enables students to solve problems without being taught specific procedures and also to understand more about how problems work. Conceptual instruction therefore is a type of instruction where emphasis is placed on teaching the major concepts in the subject to be taught (Gobinath, 2001). Conceptual instruction according to Ibrahim, Erdal and Mustapha (2009) is the process of acquiring a better understanding in which concepts are exposed to the impacts of new data. It seeks to use the new knowledge to improve the concepts that organize our thought, while conceptual problem is a problem of which solution requires understanding of the concepts. Chemical educators

and teachers have often assumed that success in solving quantitative problems should indicate mastery of chemical concepts (Nakhleh, 1993), which shows that concept learning is very vital in learning practical chemistry.

2. 3. 1. Concept Acquisition

Concept are mental categories that help us classify objects, events, or ideas and each object, event, or idea has a set of common relevant features (Ratcliff, 2006). It is something that somebody has thought up or somebody might be able to imagine (Encarta Dictionary, 5th ed, 2009). It can also be seen as an idea of what something or someone is like, or basic understanding of a situation or principle. Views on how people acquire concepts are guided in large part by which theory of concept determination is believed. (Cambridge Advanced Learners' Dictionary, 3rd ed, 2009).

Research on acquisition of concepts is often seemingly contradictory because individuals use different types of strategies depending on the situations, the type of information involved, and any beliefs about what the structure of the underlying concept is. Concept acquisition is probably a complex process with a number of strategies available depending on the perceived situation. When individuals are trying to form a concept, and feedback is given about group membership or non-membership, the individual tend to form and test hypothesis. Bruner (1956) and his colleagues did significant work on this by examining the way the participants tried to identify a concept provided by the researchers. The participants chose cards and were told whether each card chosen was a member of the group or not. All the participants formed hypotheses and then tested them, but the strategy to achieve this differed across participants. Some participants picked a card that was a member of the group and then tested cards that differed by it in only one respect to determine which aspects of the cards were critical and which were not. Other participants created complex hypotheses and then chose cards that would test the most attributes at once. A third set of participants formed a number of hypotheses but tested them one at a time (Bruner, Goodnow & Austin; 1967). Psychologists use the term concept formation, concept development or concept learning to refer to the development of the

ability to respond to common features of categories of objects or events (John, 2000). Research on concepts acquisition has revealed that children learn by active interaction, initially with concrete objects and later with abstract entities (Erifyli, & Geogios, 2000).

The initial analysis of the problems faced by students suggested that, although many chemical processes are familiar in every day experience, the chemical concepts underlying these processes are themselves unfamiliar. This is because chemical models are inherently concept formation which is not related to simple recall; it is molecular outside the range of every day experience. Our goal was to help our students to develop the chemical intuition which would allow them to bridge the gap between the familiar processes and the unfamiliar chemical concepts and models (John, 2000). This is because most teachers teach factual knowledge while teaching chemistry, therefore the study intends to use conceptual instructional method to teach concepts in practical chemistry to see if it will enhance students' performance.

2. 3. 2 Concept Teaching

There are many different ways in which concepts can be taught, and there is some debate about which methods are the most effective. In general, methods differ depending on the desired outcome of the educational experience, the age of the learner, and the difficulty or abstractness of the concept being taught. Barton and Komatsu (1989) pointed out that the most basic way of teaching concepts is by determining a rule or set of rules for the concept and having the students memorize them. The students can then apply the memorized rule or rules when prompted to make decisions about class membership of novel items. Although this does achieve some objectives of concept learning (i.e. allowing the students to make judgments about class membership), it does not necessarily provide a solid foundation for comparing the concept to previously learned concepts, a basis for learning new concepts, or a

strong likelihood that the rule will be applied in novel situations when the student is not prompted. To provide students with a more solid understanding of the concept, additional information is often useful. Students can be provided with the items that are similar to the concept but that differ on one or more dimensions, making them non-members of the category in question. To achieve more complete student mastery of the concept, students and the educator can discuss what makes other similar items non-member of the class. Students can also be shown members of the concept that differ significantly but are still category members. This can help students create a rich and complex understanding for the concept being studied (Barton & Komatsu, 1989).

The prototype is an abstraction of the central properties and need not correspond to any example (Palmer, 2002). Moreover, one body of research findings highlights the importance of conceptual understanding for successful problem solving and quantitative thinking in chemistry and suggests that students' inadequate and incorrect conceptual knowledge impede successful problem solving in stoichiometry (Boujaude & Barrakat, 2003). But simple recall or discrimination learning is not concept learning. The important categories that don't refer to concept learning are:

(i) Verbal information: reciting something from memory, e.g. recall as definition, tell a poem.

(ii) The first level of intellectual skill discrimination: Recognizing that two classes of things differ e.g. be able to identify objects, features, symbols, etc. as not being the same. Concept teaching is a tedious task. It requires dedication and devotion to motivate the learners to imbibe concepts and to master skills (Khalil, 2009).

2. 3. 3 Problems of Concept Learning

All students learn concepts at different rates, and a student who demonstrates mastery of one concept very quickly may find another particularly challenging. However, some students have more difficulty in learning concepts, those with learning disabilities often have a difficult time learning concepts. Although the degree of difficulty and the type of concepts that commonly present problems differ depending on the learning disability and the degree of disability of an individual child. Basic math concepts, time concepts including time sequencing and reading concepts are especially likely to present significant challenges. Students with such problems of learning concepts may benefit from additional educational strategies to help prevent the student falling behind. (Barton & Komatsu, 1989).

Children and adolescents often bring a lot of information in to classroom. Unfortunately information gathered through life and experiences outside the classroom is not always completely accurate. Many children have previously conceived notions of concepts before being exposed to them in a classroom setting. While mastering a concept in the classroom involves conceptual instruction, that is replacing a previously held concept with a new one, students can encounter difficulties. It is important to identify situations in which previously held concepts conflict with the concept being taught, because different educational strategies may be appropriate for each.

Most of the literature reviewed about the difficulties encountered in concepts learning is found mostly in the sciences. This is because students often have ideas about natural phenomena, such as what causes rain, and why it is dark at night, before learning about them in school, it may be difficult for students who believe they understand something to think outside that understanding or to accept different ideas presented by other students. In this case, teacher provided rules and critical criteria can help a student overcome a previously believed, but not correct concept. Teaching conceptual instruction can also be accomplished

by discussing student preconceptions about concepts, discussing evidence contrary to the preconceived concept, and guiding the students through a changing understanding to mastery of the correct concept (Merrill, Tennyson & Posey, 1992).

2. 4 Models and Theories of Concept Learning

There are many different theories about how concepts are learned, what information people have when they have mastered a concept, and how information about new items is related to previously learned concepts. Some of these models are as follows:

(i) Tennyson and Cocchiarella Model of Concepts Teaching

Concept teaching has to be carefully planned to go from simple concrete concepts to complex concepts. Tennyson and Cocchiarella (1986) suggested a model for concept teaching that has three stages

(d) Establishing a connection in memory between the concept to be learned and existing knowledge.

(e) Improving the formation of concepts in terms of relations and

(f) Facilitating the development of classification rules.

This model acknowledges the declarative and procedural aspect of cognition. Concepts can be thought of, not as a list, but as a distribution of properties, some more central or typical of others.

Merrill, Tennyson and Posey (1992) proposed that another way of teaching concepts is a student-centred, hands-on approach where integrated teaching strategies can be use. This approach may be more helpful when teaching concepts to students with more advanced critical thinking skills. Having students decide on the defining characteristics or most ideal examples of a class or category can provide an understanding of a concept deeper than that provided by memorization. Students may be provided with a number of examples of members of a category or class and then be prompted to vocalize their reasoning in

categorizing those examples. For more abstract concepts, students can be prompted to think critically and debate between themselves why some examples are members of class when other seemingly similar examples are not. Additionally, the teacher may provide new examples, and the students can discuss where they believe the examples fit, and why they classify them in that way (Merrill, Tennyson & Posey, 1992).

(ii) The Classical View

The classical view of concepts is based on the idea that concepts are defined by a list of rules. It is the first view on record about the idea of concepts, and dates back to Aristotle each concept is believed to be defined by a list of relevant rules or characteristics, all of which are necessary for the object or instance to be a member of that category or class.

Example for identification of pH of a solution in practical chemistry, there are rules to determine whether the substance is acidic, neutral or alkaline. All of the rules taken together that govern a category are sufficient to make something identifiable as a member of that category or class. In the 1970s Eleanor Rosch demonstrated that people did not hold lists of attributes when deciding category membership. Instead, she found that individuals had a mental picture or belief about what made up an example of a member of a class, not a list of well-defined rules (Rosch & Mervis, 1975).

(iii) Prototype Theory

The prototype idea of concept learning was build on the research done by Rosch and Marvis (1975). Central to this idea is the concept of a prototype that exists as the ideal example of each category or class for which a concept has been learned. A prototype is an object or item that is the most typical of that concept. There is some debate about whether the prototype is a real example that has been seen or experienced, or if it is an amalgamation of various example of the concept. If it is an abstract amalgamation it can actually be seen as

being more typical of a concept than any actual instance of that concept could be. To determine category membership or non-membership of novel items each new item is compared with the prototype and degree of similarity reviewed. Proponents of the prototype theory also often believe that information about examples are organized as being more or less similar to the prototype. In practical chemistry, there are different categories of indicators such as acid-base indicators, redox indicators and other analytical special indicators. The acid-base indicators are further categorised based on the strength of acid or bases involved during the titration.

A fairly broad body of evidence developed in the 1970s and afterward in support of prototype theory. Studies found that participants responded faster to questions about category membership when the item in question was a more typical member of the category than when it was not (McCloskey & Glucksberg, 1979). Although the developing evidence supported the prototype theory much more strongly than the classical theory, some problems with prototype theory become apparent. Researchers began to find that participants judged items to be more typical of a category in some situations than in others, which prototype theory had difficulty explaining. Also prototype theory did not explain cases in which an item was very typical of a certain category but was identified as a member of a different category of which it was less typical.

(iv) Exemplar Theory.

The exemplar theory of learning states that specific examples of concepts are learned, instead of a generalized or prototypical example or a list of specific required characteristics. Proponents of this view believe that although not every example that an individual come across is stored in the memory, many examples are retained. In this way novel items or circumstances can be compared to examples that are stored in the memory. Novel items that are not similar to any of the stored examplars are therefore very difficult for people to put

into any specific category. Some people believe that the more typical the category a specific example is, the more likely it is to be stored as an examplar of that category.

The examplar view explains many of the results found during research on concept learning and categorization. As discussed above, participants tend to respond more quickly when asked about the category membership of items that are typical of the category in question. This is because these items are more likely to be stored exemplars or more similar to store exemplars. The exemplar theory also has problems explaining some things. It is not clear how many exemplars are stored or how the determination of storage is made. Another objection frequently raised is that it requires that individual store many different exemplars for each concept, taking up vast quantities of long-term memory, more so than a single prototype would require (Rosch & Lloyd, 1978).

(vi) Bruner's Theory of Concepts.

Bruner (1967) formulated a concept formation theory that involved cognitive processes, i.e. hypothesis testing about a concept by making guesses about which attributes are essential for defining the concept. Concept attainment is "the search for and listing of attributes that can be used to distinguish examplars from non examplars of various categories (Bruner, Goodnow & Austin, 1967). A major theme in the theoretical frame work of Bruner is that learning is an active process in which learners construct new ideas or concepts based upon their current/past knowledge. The learner selects or transforms information, constructs hypotheses, and makes decisions relying on a cognitive structure (i.e. Schema, mental models) provides meaning and organization and allows the individual to go beyond the information given.

As far as an instruction is concerned, the instructor should try and encourage students to discover principles by themselves. The instructor and students should engage in an active dialog (i.e. Socratic learning). The task of the instructor is to translate information to be learned into a format appropriate to the learner's current state of understanding. Bruner (1966) states that a theory of instruction should address four major aspects:

(i) Predisposition towards learning

(ii) The ways in which a body of knowledge can be structure so that it can readily be grasped by the learner

(iii) The most effective sequence in which to present the materials

(iv) The nature and pacing of rewards and punishment.

Good methods of structuring knowledge should result in simplifying generating new propositions and increasing the manipulation of information. Bruner's model was later refined in several designs e.g Taba's (1967) instructional design model or Joyce and Weils (2000) "attaining concepts" model of teaching. Merrill and Tennyson (1977) based his model on component display theory and argued that concept formation focuses on attributes and examples. As instructional designers, the goal of this model was to reduce overgeneralization, under generalization and misconception.

Rosch and Lloyd (1978) suggested that the natural concepts in everyday life are learned through examples rather than abstract rules. Anderson Adaptive Control Thought (ACT) theory suggests that long-term memory is an interconnected network of prepositions (facts or concepts). Only a subset of interconnected prepositions are easier retrieved a concept that has many connections is elaborated. Another constructivist model e.g. Hanusin and Lee (2007) is the most popular version represented as part of helping students' sequential learning to bridge prior knowledge and new concepts. (Boddy, Watson & Abussan, 2003; Abell & Volkman, 2006; Bybee, Taylor, Gardner, Scotter, Powell, Westbrook, & Larides, 2006).

(v) Gagne's Theory of Learning

Robert Gagne's theory of learning often referred to as Gagne's theory of learning hierarchy. He states that "the learning of new concepts, or skill depends upon the mastery of pre-requisite concepts. This implies that prior (i.e. previous) knowledge determines what further learning may take place which also implies that materials meant for learning must be sequentially structured by the teacher (NTI, 2010).

Gagne emphasizes the importance of task analysis of instructional objectives. He also believes in task analysis of the concepts, skills and knowledge to be taught. Gagne's theory believes that materials meant for learning i.e. (learning task) in order for the learner to acquire the desired knowledge (i.e. terminal task) must be sequentially structured. So that the learning of one topic (i.e. acquisition of one knowledge) aids the learning of the next higher topic. In Gagne's hierarchy of learning, problem solving is the highest level, while lower levels involve facts, concept and generalization. Retrieved on Monday, 22nd, from http://www.springerlick.com.conment, (2007). Gagne's theory also advocates administration of test to find out whether the students possess the relevant pre-requisites for the new knowledge.

The applications of Gagne's theory of learning to concept teaching are as follows:

Firstly, contents in science subjects should be arranged in hierarchical fashion so that those simpler abilities and concepts which are necessary for later learning are mastered first.

Secondly science teachers need to state specific objectives for learning any material and also he developed a very useful five category system for examining the different types of learning outcomes which could be applied for science teaching as (a) intellectual skills (b) verbal information (c) attributes (d) motor skills and (e) cognitive strategies.

Thirdly, the contents in science curriculum should be arranged hierarchically so that the simpler contents are treated first at lower class before the complex ones at higher class.

Finally after completing the structured hierarchy of learning task, the teacher administered diagnostics test in order to find out the point where the learning hierarchy can start.

(vi) David Ausubel's Theory

Ausubel (1968) formulated subsumption model of learning which is based on prior knowledge and is used for the interpretation of new information the interpretation of new information to be learned. Thus he proposed the idea that meaningful learning takes place only when a general subsuming concept is available in learners' cognitive structure and that such idiosyncratic concepts are usually derived from currently held concepts in the society.

Ausubel (1968) states that concept formation involves deliberate introduction of certain concepts and sub-concepts in order to enhance meaningful learning and retention of the learning materials perceived difficult to learners. The introductions of materials are meant to provide pre-requisite knowledge that would assist the learners to understand a specific concept. He referred to sub concepts as advance organizer which he operationally defined as introductory materials at a high level of abstraction, generality and inductiveness.

According to Ausubel, the expository advance organizer can be used when no anchoring idea are available to the learners. That is, when the new learning material is unfamiliar to the learner. Ausubel, asserted that for any meaningful learning to take place new materials to be learnt must be carefully linked to the learners' prior knowledge. Ausubel has suggested that meaningful leaning can be achieved only when there pre-exist in their mind the necessary relevant concepts and cognitive structures (subsumers) that will subsume the new knowledge. Otherwise, rote learning has to be invoked.

If science teachers' are aware of Ausubel's (1978) recommendation that the most important single factor influencing learning is what the learner already knows, and use the basic demands of the theory, and such facts in teaching the learner, then learning of science

can likely be improved. Ausubels' ideas, has been fully utilized by science education researchers in the area of cognitive science and they have revealed the importance of the great ideas of Asubel they include Zuzovsky (1994). Therefore in this study, Tennyson and Cocchiarella model of concept teaching will be used where there is emphasis in establishing connections between the learner and the concepts to be learnt.

2. 5 Practical Activities in Science

Practicals are an essential part of the science curriculum. This is a truism which cannot be disputed. What can be disputed are the motives for their use. As vehicles for the teaching/learning of the substantive structure of the scientific domain. On the other hand practical are the proper vehicles for the teaching/learning of the syntactical structure of the scientific domain (Paul, 1992).

Practical activities had been given a central and distinctive role in science education. It helps students' to understand abstract concepts and develop reasoning skills and scientific methods of investigation to a degree that cannot be accomplished by lecture or demonstration (Hofstein & Lunetta, 2004; Domin, 2007). Nevertheless, traditional experiments have been blamed as "cook book exercise" that students are not stimulated intellectually and thus little motivated because they use highly structured materials to verify concepts presented previously in lecture (Monteyne & Cracolice, 2004).

For instruction to be successful in practical, it is important to select an appropriate type of laboratory for its purpose (Domin, 2007). It may appear to be more about process because what students observe is a function of when, how and with what tools they choose to observe. At the same time what students observe is also a function of what they expect to observe and how they interpret their observation is clearly influenced by what they already know and believe about the physical world national research council (NRC, 2005).

Practical work is a characteristic element in science teaching at all levels. A chemistry curriculum without experimental work is unthinkable. It would be generally accepted that laboratory training covering the manipulation of great variety of equipments, a whole range of simple and more advanced measure techniques, the save and clever handling of both relatively harmless and dangerous chemicals, separation and purification of synthetic products are part of every chemistry students' experience (Josephsen, 2003).

Several workers (Kirschner, 1992; White, 1996; Hosftein & Lunetta, 2004) have analyzed such often held views on the role of experiments and practical work in school and argue that experimental and practical work in school should be included if it allows the learner to:

(1) have practical skills (through exercises)

(2) practice academic processes through (investigation)

(3) acquire experience with phenomena and materials (through activities with much observation and manipulation) which gradually accumulates as tacit knowledge or fingnerspitznege fuhl (German for feeling at the fingers). Most chemistry educators regard practical chemistry as very important for various reasons which includes: motivation, concept learning and the development of skills and appropriate scientific attitudes. This is in line with the objectives of chemistry education. (Bradley, 1999;

N. R. C., 2002). Chemistry is essentially a practical oriented subject which demands proper exhibition of good study behaviour for effective interpretation of existing phenomena (Njelita, 2008).

Lee and Fraser (2001) report that science teachers usually did not place much value on laboratory activities since they feel this takes time away from teaching to cover the prescribed examination curriculum. Akpan (1999) observed that lack of practical activities by

chemistry students had resulted in poor communication and observational skills, the absence of these skills gave rise to students' poor performance.

The National Research Council (2002) also reported that students' do not learn much from many laboratory activities and that the activities in many of them do not clearly connect to the rest of the class. With cookbook learning (where by students only follow direct instructions), students get the impression that only the final result and calculations matters.

The most important feature of effective science education is to support theoretical explanation with actual practices in the laboratory. In the studies of Hofstein and Lunetta (2004) on this issues, the laboratory practices, generally aim to improve the students' abilities by providing observation and equipment utilization for conducting the experiment which has different dimension of safety design.

Table 2.1 The different Types of Chemical Experimentation, Dimension of Safety and Design.

Type	Purpose of activity
Synthesis	To device and control a chemical reaction to give an intended chemical substance (an intended formation of a chemical bonding).
Separation	To isolate a particular pure substance or group of substances from a mixture.
Detection	To prove the presence of a particular pure chemical substance or component in a sample
Quantification	To show how much of a given chemical substance or component is present in a sample.
Identification	To demonstrate the identity/stoichiometry of a particular substance or well defined mixture of substance.
Characterization	To determine a particular qualitative or quantitative property of a pure chemical substances in a component, or a well defined mixture of substances.

Source: Josephsen (2003)

Practical activities are central features of science teaching. The roles of practical activities in science teaching can be classified into:-

(a) Acquiring information, concepts and principles.

(b) Developing process skills

(c) Learning about the nature of science.

(d) Improving attitudes to science (Clark, 2003)

Traditionally, chemistry courses at all levels have included instruction in laboratory setting where students follow procedures directing them to mix chemicals, make measurements, analyse data and draw conclusion, at the elementary, secondary and college levels the laboratory work frequently consist of what is generally described as "cook-book" exercises at the higher levels attention is focused on discovery and the development of technical skills to conduct original research (Bassam, 2003). The role of practical work then in the teaching and learning of science content is to help students' make links between two domains of knowledge: the domains of objects and observable properties and event on one hand, and the domain of ideas on the other hand (Millar, Tiberghien & Marechal, 2002).



Fig 2.2 Practical work linking two domains of knowledge (Millar, 2004)

Practical work is nonetheless necessary for developing students' understanding of scientific concepts and explanations. For example, when students measure the temperature over a period of time of water in beakers with and without insulating jackets, they are coming to see this phenomena in terms of theoretical models of energy moving spontaneously from regions of higher to lower temperature at a rate which depends on the material in between (Millar, 2004).

When practical concepts taught are linked to things around the learner's environments, it makes for better understanding and learning effectiveness is enhanced. Thus, during practical lessons, activities that are related to the concepts within the environment should be linked to it for students to appreciate that science is not far from them (Olayiwola & Sawere, 2008). Practical chemistry at the school certificate level is made up of two components; they are volumetric or quantitative analysis and qualitative analysis. These form the first and second questions of any school certificate practical chemistry examination with the third question as short-structured items to test some general principles of chemistry. The distribution of marks to these three questions by the various examination boards councils follow almost the same pattern and ratio of 11:9:5 or 22:18:10 for questions 1,2 and 3 respectively (Ochonogor, 2008).

Qualitative analysis according to Oriafo (1985) is aimed at demonstrating proficiency in making reasonable, acceptable and accurate inferences from experimental observations; and identifying unknown ions vis-à-vis elements present in compounds, observation that leads to proper inference. Every chemistry teacher is expected by the nature of the subjects to be practically minded while presenting various chemistry topics to the students especially metals, non-metals and their compounds and the nine common gasses. The gases are oxygen, hydrogen, carbondioxide, hydrogen sulphide, sulphur (iv) oxide, chlorine gas, nitrogen (iv) oxide, ammonia and hydrogen chloride gas (Ochonogor, 2001; WAEC, 2004).

Students have difficulty in erecting apparatus, and in keeping a tidy and dry working bench and a floor space clear of dirt. It should be stressed that untidy work leads to accidents and that the laboratory sinks are not receptacle for dirty apparatus. Practicals are essential part of the science curriculum. This is a truism which cannot be disputed. Practicals on the other hand, are the proper vehicles for the teaching/learning of the syntactical structure of the

scientific domain. Chemistry is essentially a practical oriented subject which demands proper understanding of the theoretical concepts that underlie the practical activity.

2. 5. 1 The Roles of Laboratory Activity in Practical Class

Laboratories are one of the characteristic features of education in science at all levels. It would be rare to find any science course in any institution of education without a substantial component of laboratory activity. However, very little justification is normally given for their presence today. It is taken for granted that experimental work is a fundamental part of any science course and this is especially true for chemistry courses (Norman & Iqbal, 2007).

One of the main reasons to question the place of laboratory teaching is that laboratory programmes are very expensive in terms of facilities and materials, but also more importantly, in terms of staff time (Carnduff & Reid, 2003). It is important to think about goals, aims and objectives in the context of laboratory work. Laboratory work is used to describe the practical activities which students undertake using chemicals and equipments in a chemistry laboratory. Hawkes (2004) has challenged the place of the laboratory in many higher education chemistry courses. He argued that the evidence does not support the idea that the laboratory assists in achieving many of the aims of chemistry courses. He noted "The enormous expenditure of time and treasure and student dislike of laboratory teaching demands substantial evidence that it has value commensurate with its cost and with the loss of subject matters that must be omitted to make time for it". Laboratories are therefore vital for the teaching and learning of chemistry there are different types of laboratories according to Paul (1992). Which are as follows:

(a) Wet laboratories-are the most common types found in science curricula, they provide hands-on experience in a laboratory setting. These laboratories can be formal laboratories

(also known as convergent or cook book laboratories), experimental laboratories (also known as open-ended or discovery laboratories), or divergent laboratories (a compromise between the two previous laboratories are often called guided discovery laboratories.

(b) The academic or formal laboratory, also called traditional, structured, convergent cook-book laboratory, often functions primarily to verify the laws, principles, concepts and facts taught in lectures and given in textbooks. In such a laboratory the student is told exactly what to do, they must complete their experiments in rigidly set of time and should arrive at the (explicitly implied or explicitly stated) expected result. Since the experiment is a mere extension of the lecture or textbook, often very little attention is paid to the apparatus in the laboratory. Laboratory reports made by students are seen as mere obligations and bear little resemblance to reports made by professional scientist.

(c) The experimental laboratory, also known as open-ended, inductive, discovery oriented, unstructured project or undergraduate research laboratories contrasts greatly with the academic laboratory. The student here is presented with problems in experimentation meant to challenge the activity and creativity without being so complex as to be un resolvable. Instructions are general, except in cases where a mistake would be costly or dangerous. The experiments are often design to show the limitations of theory while at the same time showing the necessity of theory in carrying out meaningful experiments through illustration of the profound difference as well as the complex interdependency between theoretical and experimental science. According to Azuka (2008), laboratory teaching

Method allows useful skills in the learners such as:-

(a) Verification activities where students are allowed to verify abstracts knowledge that had been taught in class.

(b) Exploratory activities, which give students opportunities to handle materials which they can become aware of new materials and scientific phenomena.

2. 5. 2 Problems of Teaching Practical Chemistry at Secondary School

The root cause of low performance by students is traced to the approaches and pedagogies employed to deliver the course content. Some teachers consistently use the note they made when they left school for several years without updating their knowledge. These are some of the reasons for poor performance of our student in examinations particularly chemistry that is deemed abstract and difficult (Chukwu, 2008).

Chemistry is essentially a practical oriented subject which demands proper exhibition of science process skills acquisition and concept for effective interpretation of existing phenomena. Njelita (2005) identified that chemistry teachers classroom were extremely theoretical, teacher dominated and didactic approach were mainly used which encourage rote learning and memorization of facts, students were rarely exposed to practical work. Hence, Akpan (1999) indicated that only about 39.5% of overall time was used for practical which represents low rate of practical activities. Furthermore, the WAEC chief examiners report of (2007) shows that students poor performance is due to:-

(c) Poor practical exposure and conceptual understanding of practical questions.

(d) Poor calculations, omission of units or wrong units.

(e) Poor knowledge of significant figures.

(f) Inability to represent the results of an acid-base titration in a tabular form and alteration of titre values to correspond with the supervisors titre.

(g) The use of wrong mole ratio expression

(h) The wide range differences in the concordant titre values.

(i) The use of wrong expression for molar mass g/dm^3.

(j) The use of wrong expression and formulae in calculating the concentration of either the acid or the base

(k) Wrong substitution of values in a formula.

In addition to the above findings, it is observed that during the acid base titration, student lack manipulative skills in handling apparatus, some swallow the base in the process of sucking others could not detect the initial colour change or the endpoint. There is also inconsistency in the burette reading. The three important and commonly encountered problems by the students in qualitative inorganic chemistry practical are:-

(1) Steps to follow to get accurate titration results.

(2) Step to follow to identify the correct anions and cations.

(3) General knowledge of the uses of the apparatus and reagent in the laboratory.

Close studies by Ochonogor (2001) and Ababio (2004) have revealed that many students dread qualitative analysis aspect of practical chemistry for such reasons as:

(a) Lack of proper theoretical chemical information about most non-metals and metals whose identification and separation into composite ions from the basis of qualitative analysis

(b) Poor observatory skills among the students.

(c) Impatience during practical lessons

(d) Poor reporting styles employed

(e) Improper ways of manipulating materials and apparatus for effective results.

(f) Failure of many teachers to make qualitative analysis an interesting aspect of practical chemistry before the students.

The problem faced by many students during SSCE/NECO examination is inability to identify the metallic as well as non-metallic radicals given to them during chemistry practical examinations. Some students do not know when a gas is evolved, the colour or odour of the gas, the chemical test for a given gas so as to confirm the presence of such a gas from a given anion. The action of the gas or a given solution on litmus paper (Ifemuyiwa, 2008).

Question 3 in the SSCE/NECO examination test students general knowledge of practical work, including setting up of the apparatus, identifying items of set-ups and expected observations and inferences from specified reactions (Akpan, 2005) WAEC (2004-2007) show students deficient in question 3 in the following areas.

i) Drawing and labeling of diagrams, detecting faults in experimental set up among others. Teachers should expose the students to laboratory apparatus and set ups in practical, to allow students use the apparatus regularly for familiarity.

ii) Description of procedures: students cannot describe experimental procedure orderly as expected e.g outline the procedure of how to recover pure sample of sodium chloride (NaCl) contaminated with methyl orange. They can't explain the procedure properly.

iii) Students find it difficult to distinguish test, observation and inferences for chemical substances e.g distinguishing alkanes and alkenes using bromine water or $KMnO_{4(aq)}$ to distinguish the two. Alkenes decolorize bromine water or reduced $KMnO_4$; while alkanes do not. Instead, some students use the reagents wrongly and makes wrong deductions. Some of the students weaknesses according to Okoko (2008) as observed by the chief examiner are as follows:-

(1) Failure to show details of how data derived were arrived at.

(2) Arithmetic errors and omission of units from stated value.

(3) Imprecise statement and spelling errors.

Chemistry teachers in senior secondary schools should take note of these students' weaknesses in answering chemistry practical questions of WAEC/NECO and guide the students through class instruction to effect change in their performance in SSCE. A major problem in science education is that practical work in conventional courses (often equivalent to laboratory bench work) is poorly related to course objectives and consist of exercises for developing manipulative skills rather than problems in a systematic thinking. Successful

progress in the course depends upon the students understanding the results of a series of experiments integrally related to the science concepts within the course. Practical when properly planned can provide a favourable avenue to concept attainment but there must be opportunities for using alternative procedures, devising related experiments, and choosing the means for recording and interpreting observation (Paul, 1992). Generally, some of the concepts in practical are misconceived by most of the students due to inappropriate conceptual understanding of chemistry practical concepts (Muhammad, 2007). Chemistry practical concepts will be taught using integrated teaching strategy to enhance conceptual understanding of S.S.II science students.

2. 5. 3 Chemistry Practical Skills

Chemistry practical skills are science process skills (Okebukola, 2002; Njoku, 2005). Those skills which scientist employ in data gathering, transformation and arrived at conclusions. They are taught as part and parcel of chemistry curriculum. They are acquired in activities through training and direct experiences. The acquisition of all science process skills by learners is influenced by their cognitive knowledge-based. Shaibu and Mari (2002) observed that there is a need for readily available, standardized instrument to measure the acquisition of science process skills among science students. The importance of chemistry practical skills cannot be over stressed.

For students to acquire all the science process skills, conceptual understanding is very essential, it serves as the foundation for both enquiry and development of intellectual skills which enhance the learning of chemistry (Bugaje, 2010). Akalonu (1995) states that students fail to acquire the necessary practical skills for success in the external SSCE chemistry practical examination. Bybee, Buchwald, Crisman, Kuebis, Matsumotor and Mclnerney (1989) identified practical skills as having enduring quality of enabling the individual acquire

and process information to solve problems even when the information base changes. Njoku (2005) says "the science process skills are not easily lost once acquired and can be applied in many other problems situation different from the ones in which they have been acquired.

Njoku (2005) observed that WAEC uses practical text/examination to asses students acquisition of various chemistry practical skills. In these tests, candidates are required to carry out certain chemistry practical activities following some given instructions. The scores of the candidates obtained through the marking of their practical reports indirectly indicates the levels of practical skills they could demonstrate during the practical examination. This mode of assessments is also adopted by chemistry teachers who prepare the students for Senior School Certificate Examination (SSCE).

Chemistry is essentially a practical oriented subject which demands proper exhibition of science process skills acquisition and conceptual understanding for effective interpretation of existing phenomena. Akpan (2005) has also observed that lack of practical work by chemistry students had resulted in poor communication and observational skills and that the absence of both skills gave rise to students' poor performance. Njelita (2005) observed that chemistry teachers employed the strategy that is mainly teacher dominated and didactic approaches were mainly used which encouraged rote learning and memorization of facts. Students were rarely exposed to practical work; as a result, students were engaged actively in hands-on activities which exposed them to acquisition of science process skills.

Science process skills are the processing strategies which a science teacher brings to bear in solving problems (Njelita, 2005). Science process skills are essential instruments used in studying science, the skills enable learners to operate like scientists. Science process skills aid the development of creativity in the learners. For a student to make discoveries he has to perform certain mental processes by so doing, concepts and principles are discovered which aid problem-solving. These skills are used to promote inquiry in practical chemistry (Njelita,

2009). Chemistry teachers are therefore expected to expose learners to proper conceptual understanding of chemical concepts and hands-on activities that will aid them in the acquisition of science process skills, because without these skills the concept learned cannot be properly applied in conducting experiment in the laboratory. In this study the students' practical skills was assessed using chemistry practical performance checklist to find out whether conceptual instructional method has any effects on students' practical skills. Good conceptual knowledge of practical concepts enhances science process skills used in solving problems.

2.6 Instructional Strategies and Students' Attitude in Science.

Attitude is viewed as a set of affective reactions towards an object; it is derived from concepts and beliefs that the individual has concerning the object, and predisposing the individuals to behave in a certain manner toward the object (Ibrahim, 2000). Attitudes are built up largely as a product of unique experiences and each individual will interpret evidence, anticipated events and make decisions in the light of the attitude possessed.

Attitude which is an expression of likeness or dis-likeness plays a significant role in the learning of science subjects (Situ, 2008). Students attitude towards science subject is influenced by the instructional strategies employed in the process of teaching (Timothy, 2005). Many factors could contribute to students' attitude towards studying chemistry such as: Conceptual instructional method where different strategies are employed for effective teaching of concepts and the method is student centred which can directly affect the students' attitude. Krough (2000) concluded that a number of factors have been identified as related to students attitude to science. Such factors include; teaching methods, teachers attitude, influence of parents, gender, age, cognitive styles of pupils, career interest, societal view of science and scientists, social implication of science and scientist. Kola and Dube (2005)

worked on the influence of conceptual instruction on students attitude towards science subjects. The result was that attitudes become more positive after instruction.

Ibrahim (2000) also concluded that groups that score significantly high in science achievements test also score significantly high in attitude test after instruction. Gazi, Oloruntegbe and Tunde (2010) reported that several factors can work in concert to influence students attitude and behaviour toward quantitative aspect of practical chemistry, instructional strategy is one of such factors, and the results obtained indicated that these factors actually influence the attitude of the subjects towards volumetric analysis exercise.

Adesoji (2008) reported that students exposed to programmed instruction recorded higher and more favourable attitude towards mathematics. Liza (2010) asserted that there was a positive significant relationship between the students' attitude towards chemistry and the instructional strategy employed which leads to better performance. While students attitude after instruction seems to greatly influence their performance in chemistry. The students positive attitude towards chemistry as observed by Therefore conceptual instructional method was employed in this study to determine whether there will be a change in students attitude towards practical chemistry.

2.7 Students' Attitude and Academic Achievement in Science.

An attitude towards science denotes interest or feeling towards studying science. 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). However, recent research suggests that students achievement also depends on academic enablers such as attitude and behaviour that allow the students to participate in and ultimately benefit from academic instruction in classroom (Liza, 2010). Students attitude 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 achievement (Gibbons & O'Shea, 1997). Fostering positive science attitude in students living in technological society means that science educators and classroom teachers must be able to measure students attitude as a result of quantitatively and qualitatively assessing the opinions and attitude of students towards the learning activities in which they are participating in, it may be possible to improve the quality of instructional procedures which could lead to better learning (Liza, 2010).

Students' attitude towards chemistry needs to be assessed during lesson so that the teacher can know how the students feel towards the teaching strategies used, classroom activities and the subject matter. This will assist the teacher by providing good basis for accepting useful educational inventions to facilitate chemistry learning (Muhammad, 2007). Therefore if conceptual instructional method is used as an invention prior to practical activities it might affect their practical performance. It was found by Adesokan (2000) that students still show negative attitude towards chemistry in spite of the recognition given to the subject, therefore leading to poor performance and low enrolment.

Since attitude is a concept which arises from the attempt to account for the observed regularities in the behaviour of individual person, the quality is judged from the observed evaluative response one tends to make. An individual can show positive or negative attitude towards a particular objects, subject or idea. (Kind, Jones & Barmby; 2007). It was found by Olatoye (2001) that student's attitude towards science has significant direct effect on students achievement in the subject. Students who are successful academically hold positive attitude in school and are well adjusted emotionally and socially (Jaynes, 2005). It was opined by Gibbons, Kummel and O'Shea (1997) that students attitude about the value of learning science may be considered as both an input and outcome variable because their attitude towards the subject can be related to educational achievement in ways that reinforce higher or

lower performance. This means that those students who do well in a subject generally have more positive attitudes towards that subject and those who have more positive attitudes towards a subject tends to perform better in that subject.

In this respect, measuring students' attitudes towards objects or circumstances are in demand in many fields (Erkus, 2003). Adnan and Ahmet (2006) however revealed that attitude scores of mathematics and science courses have significant relations with the scores of subtest of mathematics and science test. It has also been suggested that having negative attitude towards these courses might be taken as an important factor for the students achievement in mathematics and science has not improved by the years as expected. Carkir, Sahin and Sahun (2000), in their research on the 6^{th}grade students have found out that, the students attitude have effect on academic achievement indirectly via other variables.

Attitude is a major factor in learning because students thinking or behaviour towards it, will determine the level of their diligence and performance (Situ, 2008). Keeves (1992) asserted that attitude towards science are known to decrease as students progress through their schooling years. The implication of Keeves findings is that attention should be given to science teaching early, so as to enable students have favourable disposition toward science later in life. Therefore attitude is a significant factor that can enhance students' performance when positively inculcated in the students as a result of different factors. It is in line with this that, this study investigates the use of conceptual instruction in secondary school to find its influence on students' attitude and academic performance in practical chemistry.

2.8 Gender Difference and Academic Performance in Science

Gender and it's manifestation in various human activities appears to be a strong predictor of human conduct. In education, many differences have been documented between achievements of male and females. Many researchers and educationist feel that gender difference is one of the factors that affect academic performance. (Ajewole, 1997; Okeke, 2001). Gender difference has become a current issue locally, nationally and internationally. The concept "gender" refers to the amount of masculinity or femininity found in an individual. A normal man has a preponderance of masculinity while a normal female has a preponderance of femininity (Bichi, 2002). The influence of gender on students performance has for a long time been a concern to many educational researchers. But surprisingly no consistent results have been obtained (Francis & Babatude, 2008).

Bichi (2006) reports that many studies in Singapore suggests that boys achieve better than girls in mathematics but Shaibu and Mari (1997) in their findings on the effect of gender on students problem solving skills found out that female subject were significantly better than their male counterparts and that there was a significant difference between the male and female subject in their ability to solve quantitative problems while Iorchugh (2006) did not find either gender performing better. Okwo and Otubah (2007) in their studies on gender and cognitive styles found out that gender and cognitive styles are individually and jointly significant factors influencing students' achievement in physics essay tests. It is often claimed that very few girls choose science in school and apart from biology very few of them are keen in science subject. International studies have confirmed such a view by showing that girls are more interested and perform better in biology than boys (Bell, 2001).

Studies in Denmark have also shown that girls in the Danish upper secondary school (Gymnasium) have little interest in physics (Krough & Thomsen, 2000) but girls and boys find it relevant to know about practical applications of chemistry. They finally concluded that

Danish boys perform a little better than girls in chemistry but girls are a little more interested in chemistry than boys. Girls generally, remained illiterate and were encouraged to remain at home due to cultural reasons and their feminine roles as wives and mothers (Aluko, 2005) while Bennie (2001) states that gender stereotyping which assigns sciences as male domain is a major cause of female low participation in sciences. Okeke (2001) agreed that this may have also contributed to poor enrolment and achievement of girls in science and technology in tertiary institution. Philips (2006) had opined that girls excel consistently in arithmetic computation and are superior in reading and hand writing while boys are slightly better in arithmetic reasoning, history, Geography and Geometry. Fafunwa (1997) observed that males posses more accurate knowledge about natural phenomena than their female counterparts. Darlington (1971) in his contribution feels that sex differences affects performance, stressing that it is totally genetic incapable of being effectively modified by the environment. Edemude (1996), Adeniyi and Landu (1997) call for a gender balance through curriculum balance, attitude, opinions and socio-cultural values when dealing with different sexes.

All these have made the learning of science related courses more friendly and appealing, as such attracting more females to science (Lawal, 2009). Perhaps this could be as a result of the fact that girls still have difficulty of understanding the physical sciences notably chemistry and physics as observed by Aigboman (2002). Aluko (2005) observed that girls generally remained illiterate and were encouraged to remain at home, which make gender stereotyping to permeate the school system manifesting in both direct and subtle ways while Ogunboyede (2003) indicated that boys are not better than girls in terms of educational achievement. The results obtained for researches in gender is not consistent, some favour males while others are in favour of females and sometime there is no gender difference in the performance of students. It is based on this that gender differences will be investigated in this study by using conceptual instructional method to see if it is gender friendly or otherwise.

2.9 Overview of Similar Studies

Due to the importance of practical activities and concept learning in science education, a great deal of researches in science education have been carried out in this aspect and the following are summaries of some of such research work. Wagner's (2006) case study analysis suggests that students' conceptual understanding depends on the context, in which the concepts are being taught and therefore requires acquisition of concepts representation. Neslihan and Eser (2009) conducted a study to determine whether the development of chemistry concepts has similarities with the students' conceptual understanding. The study was carried out with a cross-sectional research in the form of a case study and the results revealed that with proper concepts teaching, students understood the concepts in chemistry better. Reform efforts that introduce conceptual instruction in mathematics have been extensively studied with mixed results.

Jodi (2010) conducted a research on the development of conceptual instruction and problem solving expertise in chemistry to find out whether there is evidence that conceptual instruction on the meaning behind calculations can be attributed to difference in problem solving and the result was that problem solving performance relates to conceptual understanding of the quantities involved in calculation. Birbili (2007) in a study, attempted to organize teaching and learning in early childhood education around concepts and generalization rather than inert facts. He stressed that teachers can facilitate concept development by putting concepts and generalizations at the centre of activities that provides the children with a wider range of concrete experiences and in a way helping them learn to observe and represent better what they see and hear. In the same study Birbili (2007) stressed that with concept based instruction, the learners are provided with varied examples of concepts being taught. Therefore, conceptual instructional method will be used to test

students' academic achievement in practical chemistry to see whether similar or contrary result will be obtained.

Khalil (2009) analysed the relationship of the concept-based curriculum with what the teachers will include in their lesson plan. The main method used in this study is exploratory and library research. The findings, however, point to the reality that given the right concept to the learners they can develop and could excel in writing persuasive essays. This study has found out that indeed concept-based curriculum affects the performance of the writers.

Clark (2003) in a study on the effect of conceptual instruction on learners performance, states that the previous research on low performing students and students disabilities indicated that significant gains in learning can be attained by intentionally designing the instruction with assessment using an instructional approach called conceptual instruction. Gabel (2003) replicated a study that involved 305 college level calculus students and 8 instructors. They investigated the effects of conceptual against procedural based curriculum. They used multiple achievement measures to determine the degree of mastery of the concepts and the procedures. The learning environment resulted in no significant deference in the students' abilities to employ procedural skills as measured. The students enrolled in the conceptual learning environment scored significantly higher than the students enrolled in procedure-based learning environment on assessments that measured conceptual understanding as well as procedural skills. These results provide evidence that conceptual instructional programmes can effectively foster the development of student understanding without sacrificing skill proficiency. In this study, the relationship between students' practical skills and academic achievement in practical chemistry was assessed after exposure to conceptual instructional method.

Douglas (1997) in his research on the effect of explicit problem-solving instruction on high school students problem-solving performance and conceptual instruction in physics. Eight physics classes with a total of 145 students were randomly assigned to either a treatment or comparison group. The four treatment classes were taught how to use an explicit problem solving strategy, while the four comparison classes were taught how to use a textbook problem solving-solving strategy. Students' problem-solving performance and conceptual instruction were assessed both before and after instruction.

The result indicated that explicit strategy improved the quality and competence of students' physics representations more than the textbook strategy, but there was no difference between the two strategies on match of equations with representations, organizations with representations, organizations or mathematical execution. In terms of conceptual understanding, there was no overall difference between the two groups. In a conceptual research conducted by Magada (1996) on the comparative study of impact of conceptual and systems approaches on the effective learning of geography, he found out that there was a significant difference in the effective learning between learners taught using the conceptual approach alone and those taught using a combination of the conceptual and systems approach. It was established that a combination of conceptual and systems approach was more effective than the conceptual approach alone.

Sevgi, Nurdane, Yezdan, Ayla and Octlay (2009) in their study evaluated whether a chemistry laboratory course called "Laboratory experiments in science education" based on constructivist instruction accompanied with concept-mapping enhanced pre-service chemistry teachers conceptual understanding. Data were collected from five pre-service chemistry teachers at a university in Ankara by means of a test and semi structured interviews. Results showed that pre-service teachers had some alternative conceptions about chemistry topics. Moreover, using constructivist instruction accompanied with concept maps as instructional

tools was effective in promoting conceptual understanding. Participants thought that concept maps were useful especially in recognizing the relationship between different chemistry concepts.

Gokhan, Alipasa and Hulya (2004) investigated the effects of students achievement of new teaching material developed for the unit "acids and bases". Also, the students' attitudes towards chemistry were explored. The new materials included work sheets base on conceptual instructional method, the sample consisted of thirty eight students. The results from the posttest indicated that the students in the experimental group taught with the new teaching material showed significantly greater achievement in the unit acids and bases than did the students in the control group. In addition, the experimental group had a significantly higher score than the control group, with regard to their attitudes towards chemistry. This shows that the implementation of the new material produced better results both in terms of achievement and attitudes.

In another study Boujaoude and Barakat (2003) investigated the relationship between students' problem-solving strategies in stoichiometry and their conceptual performance and to their learning approaches (e.g deep approach Vs relating ideas Vs intrinsic motivation among others). Based on the result that indicated a connection between sound conceptual and procedural knowledge and successful problem solving, they administered a learning approach questionnaire (LAQ) and a stoichiometry test, partially followed by unstructured interviews to forty Lebanese students (grade II, age 16-20). They derived three main types from tests and the interviews.

(i) Correct strategies which were subdivided into "algorithmic" "efficient" and "Messy" strategies.

(ii) Incorrect strategies, which were sub-divided into "incorrect strategies-incorrect answers" and "incorrect strategies – correct answer".

(iii) Incomplete Strategies

As the authors state, the majority of students participating in this study used algorithmic problem solving even when they do not have adequate understanding of the relevant concepts. In contrast to results in literature, they did not find a correlation between the factors 'learning approach' and "conceptual understanding". Furthermore they did not find any patterns in the problem solving strategies used by students with different learning approaches. In this study, the relationship between students' academic achievement and practical skills will be investigated.

2.10 Implication of Literature Reviewed on the Present Study

Literature reviewed from some studies in the area of concept-teaching, attitude and gender difference has been undertaken. The implications of the reviewed literature are:

1. the model used in the research was adopted from the literature reviewed,
2. the literature reviewed was used in the discussion of the results obtained. Some literatures were in line with the present study while others were contrary to the study.
3. students who were taught using conceptual instructional method, performed significantly better than their counterparts (Matin, Tanja & IIka, 2007). On the other hand, there was no significant difference in academic performance of students in both the experimental and control groups. When conceptual knowledge is compared with procedural knowledge, it was found that students exposed to conceptual knowledge were able to answer the problems more accurately than those students exposed to the procedures for solving the problem (Gabel, 2003). The outcomes of this reviews were summarised as follows:-

a) instructional strategies affect students' attitude towards the subject concern while the students' attitude on the other hand affects their academic performance (Adesokan, 2000; Kind, Jones & Barmbly, 2007; Liza, 2010).

b) there were inconsistent results in the area of gender, some findings were in favour of males while others are in favour of females and in some; there was no significant difference in the performance of both males and females (Bichi, 2006; Okwo & Otubah, 2007).

c) poor performance of students in practical, is responsible for their poor performance in chemistry in general. (Njoku, 2005; Omolade, 2008; WAEC Chief Examiners' Report, 2007). From literature reviewed, the aspect of relating conceptual instruction on students' performance in practical chemistry was relatively few; therefore this study investigated the influence of conceptual instructional method on students' performance in, and attitude towards practical chemistry at senior secondary school level.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The Influence of Conceptual Instructional Method (CIM) on Students' Achievement in, and attitude towards practical chemistry at senior secondary school level was investigated in this study. In this chapter, the research design, procedures along with instrument used for data collection were described. The procedure for data analysis is highlighted. The chapter is presented under the following sub-headings:

3.2 Research Design

3.3 Population of the Study

3.4 Sample and Sampling Procedure

3.5 Instrumentation

3.5.4 Validation of the Instruments

3.5.5 Pilot Testing of the Instruments

3.5.6 Item Analysis

3.5.9 Reliability of the Instruments

3.6.0 Data Collection Procedure

3.6.2. Administration of Treatment

3.7 Procedure for Data Analysis

3.2 Research Design

A pretest, posttest, quasi-experimental/control group design was used. Two groups of students participated in the study i.e the Experimental and Control groups. A pretest (O_1) was administered to the two groups in order to determine the equivalence of the groups in ability before the commencement of the treatment. The experimental group was given the treatment i.e. they were taught the concepts in Practical Chemistry using Tennyson and Cocchiarella model (1986) of concept teaching. The control group was taught the same chemistry practical concepts using the lecture method. At the end of the treatment period, a posttest (O_2) was administered to both groups of students in order to evaluate the effectiveness of the treatment for enhancing the learning of practical chemistry concepts among S.S.II students. The Research Design is illustrated in Fig 3.1

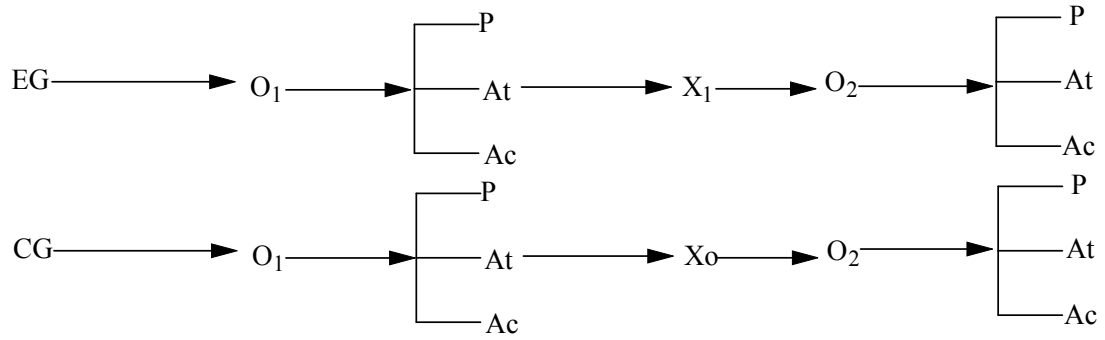


Figure 3.1 Research Design Illustrations

Where:

EG = Experimental group

CG = Control group

O_1= pretest

O_2= posttest

X_1 = Conceptual Instructional Method (CIM)

X_o = Lecture Method

P = Performance (practical skills)

Ac = Achievement

At = Attitude

3.3 Population of the Study

The population of the study comprised SSII science students in the 17 public senior secondary schools that offered chemistry in Zaria Educational Zone of Kaduna State. The schools were located in Sabon- Gari, Soba and Zaria local government areas. SSII students were chosen because in most of the schools the students were exposed to Chemistry Practical at SSII level. The population comprised single-sex and co-educational schools. There were four male Schools, four female Schools and nine co-educational schools in the population.

The total number of students in the population were 1401, comprising of 865 males and 536 females. The age range of the students was between 16 and 19 years, and most of them attended public primary schools located at their various local government areas.

The schools are listed in Table 3.1

Table 3.1 Population of the Study

S/N0.	Name of the Schools	L.G.A	Male	Female	Total
1	G.S.S. Chindit Barrak	Sabongari	102	_	102
2	Barewa College	Sabongari	150	_	150
3	G.S.S. Zaria	Zaria	95	_	95
4	Alhudahuda College	Zaria	104	_	104
5	G.G.S.S. Zaria	Zaria	_	80	80
6	G.G.S.S. Pada	Zaria	_	52	52
7	G.G.S.S. Kofan Gayan	Zaria	_	92	92
8	G.G.S.S. Chindit Barrak	Sabon-Gari	_	44	44
9	G.S.S. Kaura	Zaria	40	25	65
10	G.S.S. Magajiya	Zaria	40	39	79
11	G.S.S. Kofan Kuyanbana	Zaria	92	23	115
12	G.S.S. Aminu	Sabongari	30	22	52
13	G.S.S. Dogon Bauchi	Sabongari	45	35	80
14	G.S.S. Muchia	Sabongari	43	35	78
15	G.S.S. Dakace	Zaria	42	40	80
16	G.S.S. Yakasai	Soba	40	23	63
	G.S.S. Tudun Saibu	Soba	44	26	70
	TOTAL		867	536	1401

Source: Ministry of Education, Zaria Educational Zone, Kaduna State *(*2012).

3.4 Sample and Sampling Procedure

One hundred students served as sample for the study. Since gender is one of the variables in the research, purposive sampling procedure was adopted to ensure subjects chosen that is, both male and female had similar background, experience and environmental exposure. Nine co-educational schools were chosen for the research to ensure that both male and female students were exposed to the same mode of instructions under the same condition. Therefore only the 9 co-educational schools were chosen out of 17 schools in the population. The co-educational schools are shown in Table 3.1 and comprises of 684 students out of which 416 were males while 268 were females. The nine schools chosen were pretested and ANOVA statistical tool was used to analyse the data.

Two schools that do not differ significantly were chosen and also randomly assigned as experimental and control centres. The names of all the co-educational schools in population was written on a separate pieces of papers and all the papers were put in a container and the container was shaken very well, two schools were drawn-out one at a time, from simple balloting method used. G.S.S. Magajiya and G.S.S. Dakace were randomly selected for the study. 20% of students from the sample in each school were used for the study which is in accordance with the central limit theorem by Tuckman (1975) who recommended a minimum of 30 subjects as sample for experimental research.

Table: 3. 2 Constitution of the Study Sample

Group	Schools	Number of Class Enrolment		Sampled Student	
		Male	Female	Male	Female
Experimental	G.S.S. Magajiya	40	39	25	25
Control	G.S.S. Dakace	42	40	25	25
Total	Two	82	79	50	50

The decision as to which of the two schools was to be used as the experimental or control group was made by flipping a coin. The tail was slated for the experimental group while the head was for the control group. Based on this, G.S.S Dakace served as control group while G.S.S Magajiya as the experimental group. In each of the two selected schools, there are only two arms of science classes ($S.S.II^A$ & $S.S.II^B$). Selections of the subjects from each of the school were done in such a way that the male and female subjects were considered separately.

In the experimental school there were 79 students consisting of 40 male and 39 female. Numbers 1 to 25 was written on separate pieces of papers to represent the male subjects that will participate in the research similarly zero was written on 15 other separate pieces of papers which make a total of 40 pieces of papers which is the number of male subjects in the experimental group. The papers were folded and put in a container and the container was shaken very well. The male subjects were asked to choose only one piece of paper each and those that chose numbers 1-25 forms the sample for the study. Same procedure was used to select the female subjects but, a total of 39 pieces of papers was used similarly those that choose 1-25 forms the sample for the study.

For the control group, a total of 42 pieces for males and 40 pieces for female subjects were used. Similarly, those that chose 1-25 were used as the sample for the study.

The sample of 50 subjects was chosen in each school which is in line with national curriculum of Education (maximum of 50 students per class) for effective monitoring and evaluation.

3.5 Instrumentation

The following instruments were developed by the researcher and were used for data collection:

i Chemistry Practical Achievement Test (CPAT) (see Appendix 1)

ii Chemistry Practical Performance test(CPPT) (see Appendix 3)

iii Chemistry Practical Attitude Inventory (CPAI) (see Appendix 4).

3.5.1 Chemistry Practical Achievement Test (CPAT).

Chemistry Practical Achievement Test (CPAT) was developed with the aim of testing students understanding of chemistry practical concepts. The instrument consists of two sections: Section 'A' and 'B'. Section 'A' was adopted from WAEC past questions papers MAY/JUNE 2011 Practical Chemistry Examination. Because the content of the questions consists of the major areas to be covered in the research such as volumetric analysis, pH/indicators, acids-bases, oxidation-reduction reactions. The students were given a solution labelled **A** with concentration of 0.100$mol\ dm^{-3}$ of an acid. And another solution labelled **B** containing 2.80g$per\ cm^3$ of KOH. They were asked to:

(a) put **A** into the burette and titrate against 20.00cm^3 or 25.00cm^3 portion of **B** using methyl orange as indicator. The students were asked to repeat the titration three times to obtain **consistent** titres. After the titration, each student was asked to tabulate his/her readings and calculate the average volume of acid used.

(b) from the results and information provided above, calculate the :

(i) Number of moles of acid in the average titre;

(ii) number of moles of KOH in the volume of **B** pipetted,

(iii) mole ratio of acid to base in the reaction. They were given the molar mass of the component element [H=1.00, O=16.0, K= 39.0]

While in section **'B',** the test items were made of 10 questions, which were constructed to test the students' conceptual understanding. Items in the test covered all the areas taught by the researcher. For example volumetric analysis, concepts in quantitative determination of amount of a substance in solution, mole concepts, solutions, acid-base reactions, indicators, separation techniques among others an example of a question asked was as follows:
0.01mole of NaOH was dissolved in just enough water and made up to 1.00dm^3. If 25.00cm^3 of the solution is removed, what will happen to the concentration of the remaining solution in the flask? The CPAT items were constructed to determine students' conceptual understanding of chemistry practical concepts (See Appendices 1&2 for the questions and marking guide). The same test items were used for the pretest and posttest.

3.5.2 Chemistry Practical Performance Test (CPPT).

Chemistry Practical Performance Test (CPPT) is a checklist adapted from the IEC (2009) testing the students' practical skills in volumetric analysis (titration) such as skills in: assembling the apparatus required for the titration, clamping the burette in correct vertical position, rinsing the pipette & burette with the solutions to be used, taking the correct drop of indicators to be used, viewing the meniscus level in the burette correctly, taking the accurate volume of the base using the pipette correctly, delivering the solution of the base in to the conical flask without spillage, swirling the conical flask while the titration is in progress, the rate at which the acid solution is being added in to the conical flask during titration, when the addition of the acid solution is stopped to get the correct end-point, using a white tile in order to see the correct colour change at the end-point of the titration, using a dark paper in order to obstruct reflection while viewing the correct meniscus level in the burette, correct manipulation of the pipette in order to obtain the actual volume it is designed to deliver (25.0cm^3) among others. Each correct practical skill was scored accordingly.

The scores were as follows: very good =3marks, good = 2marks fair = 1mark and Poor = 0 mark. There were 20 basic practical skills in the check list.

3.5.3 Chemistry Practical Attitude Inventory

The CPAI was adapted from the modified Fernnema-Sherma science attitude scale of Dockpen Lawsky and Padwa (1970). It was adapted to suit the present study and thus, used for data collection. The attitude questionnaire had total number of 80 questions and was used by Dockpen etal (1970), to test for a change in attitude after teaching mathematics. The questions were adapted to reflect the concepts in practical chemistry, e.g where it says I am sure I can learn mathematics. Practical chemistry was substituted for mathematics. The questionnaire was administered to both experimental and control group. The purpose of this instrument is to determine whether students has favourable or unfavourable attitude towards the use of conceptual instructional method as well as the traditional method.

The instrument consisted of 32 items which is constructed based on the Likert – type five – point scale of Strongly Agree (SA) Agree (A) Undecided (UD) Disagree (D) and Strongly Disagree (SD) respectively. The options in the questionnaire were scored as follows: SA= 5marks, A= 4marks, UD= 3marks, DA= 2marks while SD= 1mark. The same attitude change questionnaire was administered to the subjects in the experimental and control groups before and after exposure to conceptual instruction in order to determine if there was any change in the attitude of the students towards the practical chemistry concepts.

3.5.4 Validation of the Instruments

The three instruments were submitted to the following experts for content as well as face validation: A Ph.D holder and a Senior Lecturer in the Department of Chemistry, Ahmadu Bello University Zaria, a Ph.D holder and a Chief Lecturer in the Department of Chemistry, Federal College of Education, Zaria a Ph.D holder and a Senior Lecturer in the Department of Psychology, Ahmadu Bello University, Zaria and a Ph.D holder and a Senior Lecturer in the Department of English-Language Ahmadu Bello University Zaria. A Professor in the department of Science and Mathematics-Education, Ahmadu Bello University Zaria was also one of the experts. The experts were requested to critically examine and assess all the items of the instrument, paying attention to the following whether:

i. The test items tested what they were meant to test.

ii. The Language expression was simple, clear, precise and free from ambiguity.

iii. The questions matched the ability of the students.

iv. The questions adequately cover the syllabus.

The experts made constructive criticisms and corrections as follows:-

For the chemistry practical, performance checklist, (30) items were submitted for validation to the experts. (7) items were reframed, while (10) items were cancelled making the total number of items in the check list to be (20). On the other hand, the chemistry practical attitude inventory (CPAI) items submitted for validation initially were (50) but after the validation, (10) questions were reframed, while (18) questions were cancelled and at the end, the whole questions were reduced to thirty two (32). While for the chemistry practical achievement test, (10) questions was asked and all was reframed by the experts.

3.5.5 Pilot Study

The instruments outlined are pilot-tested, before the final administration to the samples. A sample of 30 SSII students at G.S.S. Aminu Sabon-Gari Zaria were used to pilot-test the chemistry practical achievement test (CPAT), another group of 30 students from G.S.S Chindit Barracks were used to pilot test the chemistry practical performance test (CPPT). *t*-test statistic was used to test both the instruments. Similarly the chemistry practical attitude inventory (CPAI) was administered to 30 students at G.S.S. Kofan-kuyanbana Zaria city. Manwittney *U*-test was used to test the instrument.

The purpose of the pilot study according to Bichi (2002) is to:

(a). determine the reliability strength of the instrument before administration (CPAT, CPPT & CPAI)

(b). assess the feasibility of the study before trial.

(c). identify possible problems or difficulties that respondents may encounter with a view to eliminate them.

(d). diagnose possible mistakes students may commit in responding to test items with a view of eliminating them in the final treatment.

(e). determine the approximate time duration which the subjects would need to answer the test items properly. The appropriateness of the instrument in terms of clearity of the items.

(f) reliability of the test items will be determined. Also the discriminative indices and difficulty indices will be determined using the students' scores.

3.5.6 Items Characteristics of the Instrument.

Item analysis was carried out on the results of the Chemistry Practical Achievement Test to determine the facility indices (FI) and discrimination indices (D.I) of the items. They are derived as follow:

3.5.7 Item difficulty Index

This is the percentage of students who obtained the correct answer on an item. For computing the difficulty index for each item, the following steps were followed:

i) The scores on the whole test scripts were ranked in order, from highest to lowest.

ii) One third of the scores of the high scoring students and one third of the scores of the bottom scoring students were selected.

iii) The percentage of the high scoring one third and the low scoring one third of the total test items was calculated.

iv) The items difficulty index was computed by adding the percentage of those that got the items correct in the bottom scoring and high scoring groups and then divide by two, The formula is;

$$P = \frac{RU + RL}{N}$$

Where:

P = item difficulty

RU = number of students that got the item right in upper one third percent.

RL = number of students that got the item right in bottom one third percent.

N = number of students involved in the analysis (not the entire students that sat for the test).

N.T.I. (2010).

A difficulty index of 75% or higher is regarded as easy in terms of difficulty level, where the index is 25% or less, then the items is hard in terms of difficulty level. In the chemistry practical achievement test (CPAT), test items with difficulty index which ranges from 25% to 75% where retained which is in line with (Maduabum, 2004).

3.5.8. Discrimination Index (DI):

Discrimination indices of a test refer to the capacity of such a test to discriminate or distinguish between high and low achievers among students in the sample. If an item has positive discrimination index, it implies that a large proportion of the more competent students than poor ones got the item right. If the value is zero, the item has zero discrimination, which means that the items are unable to distinguish between the competent and incompetent students. The negative value of discrimination index indicates that more of the poorer students got the item right compared to the more competent ones. Mehrens and Lehmann (1984) stressed that the higher the discrimination indices the better, recognizing that there are situations where low discrimination indices is to be expected. e.g. classroom test Furst (1958) stated that discrimination indices which range from 0.30 to 0.49 are described as moderately positive and above this are highly positive.

As earlier stated, the magnitude of discrimination indices which range from 0.30 to 0.70 are used as in line with (Wood, 1990 in Lawal, 2009). The facility indices and discrimination indices calculated from the initial test items which did not fall within the theoretically acceptable range suitable for use were rejected. Therefore the test instrument was reduced from 50 to 30 items which was finally used for the study. The discrimination index was calculated using the formula given by (Furst, in Olorukooba , 2001).

$$DI = \frac{RU - RL}{\frac{1}{2} N}$$

Where:

D = discrimination index

RU = number of upper 27% of respondents, RL = number of lower 27% of respondents, N = total number of respondents. Details found in (Appendix VI)

3.5.9. Reliability of the Instruments

The degree of error or precision in which an instrument measures what it's supposed to measure is called its reliability (Odama, 1982, in Bichi, 2002). A test is said to be reliable if repeated measurements using the test gives more or less the same results. The data obtained from the pilot study was used to calculate the reliability of the instruments.

CPAT was calculated using test, re-test method and it was found to be 0.71, the reliability of the Chemistry Practical Performance Test (CPPT) was measured using Guttman split half method which was found to be 0.73, while that of CPAI was calculated using Kuder- Richardson estimate which agrees with 0.791 and is considered reliable for the study. This is in line with Uzosike (2008) who states that a reliability coefficient of 0.5 and above implies that an instrument is internally consistent and valid. Details found in (appendix VII & VIII).

3.6. Data Collection Procedure

The procedure for data collection is described as follows:

3.6.1. Pretest Administration

Before the commencement of the treatment, a pretest was administered to both the experimental and control groups. The subjects were asked to answer the questions in the Chemistry Practical Achievement Test (CPAT). The students' practical skills were tested using the chemistry practical performance checklist (CPPT) while the Chemistry Practical Attitude Inventory (CPAI) was administered to both the experimental and control groups. The three instruments were administered before the commencement of the treatment.

The scores of the pretest was analyzed to determine if there is any difference in the performance and attitude of the students in the experimental and control groups. The result shows that; the subjects in the two groups are equivalent in their ability towards practical chemistry.

3.6.2 Administration of the Treatment to the Subjects in the Experimental Group

The subjects in the experimental group were exposed to conceptual instructional method using Tennyson and Chocchiarella (1986) model of concept teaching. The concepts in Practical Chemistry were taught employing the integrated teaching strategy which involves different methods where applicable, such as: practical, discovery, problem solving among others. The teaching of the concepts was done by the researcher. The aim was to make effective utilization of the model and to ensure that the teaching procedure is in accord with the direction of the model, it was also to remove any teacher bias that might arise. The respective class teachers introduced the researcher to the students in order to create a good rapport with the students.

The first lessons in the classes were used for revision. All the teaching took place in the laboratory because of the practical nature of the concepts. The teacher used one lesson to acquaint the subjects in the experimental class with the objectives of the conceptual instructional method. The subjects in the experimental group were then exposed to the teaching using Tennyson and Chocchiarella model. The model consists of the following stages:

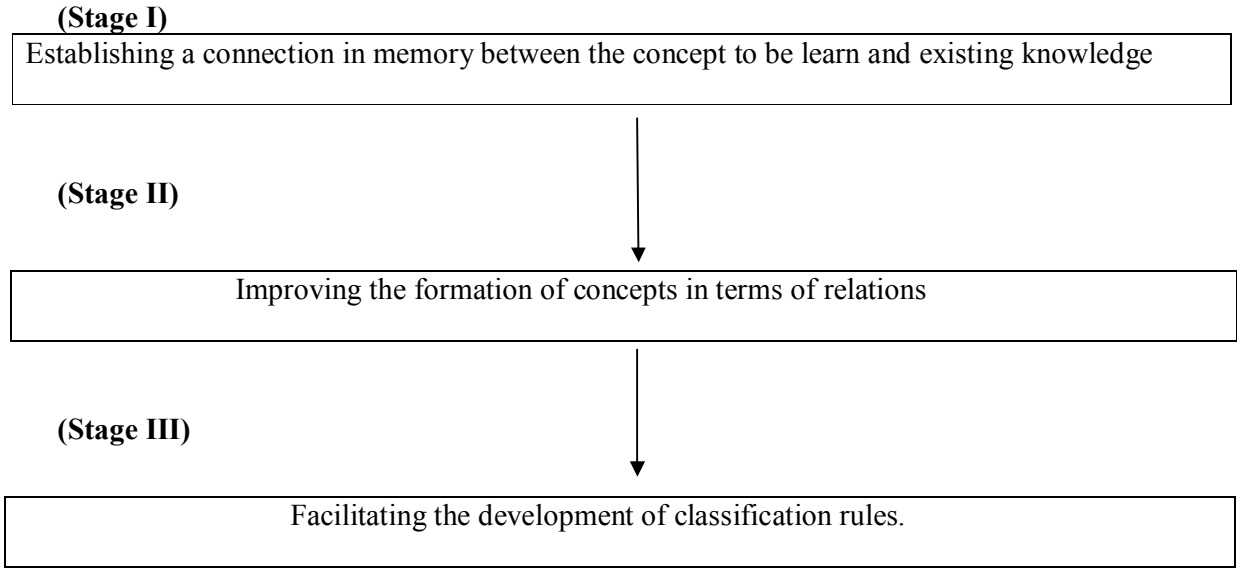


Fig. 3. 2 A Flow Chart of Tennyson and Chocchiarella Model of Concept Teaching
Source: Tennyson and Chocchiarella (1986)

Figure 3.1 is a flow chart of Tennyson and Chocchiarella (1986) model of concept teaching which was adopted and used for the present study. Lesson plans based on this model was written, below is a description of each of the stages:

1) Establishing a connection in memory between concepts to be learned and the existing knowledge. At this stage, students' previous conceptual knowledge is linked to the new concepts to be learned in practical chemistry. Questions were asked and the students allowed to give responses to the questions. They were then allowed to explore the phenomenon in questions through discussion. The students were then asked to make their conceptions clear as questions were asked.

2) Improving the formation of concepts in terms of relations. At this stage, the students encountered new information and it is expected that; through the process of exploration there is improvement in the concepts formation and the relationship is outlined clearly.

3) Facilitating the development of classification rules. At this stage, opportunities were given to the students to explain the concepts, solve some problems or give examples and where there is need for further breakdown of concepts, the concepts were classified.

This model acknowledges the declarative and procedural aspect of cognition. The duration of teaching was six (6) weeks of one hour per week.

3.6.3 Administration of the Treatment to the Subjects in the Control Group

The control group was taught the same concepts by the researcher using the lecture methods for the same duration. The notes of lessons prepared by researcher were strictly adhered to in the teaching of the subjects in the control group. The concepts was discussed and explained verbally using talk and chalk, students wrote notes where necessary and asked questions where they find difficult to understand.

During the teaching period, the teacher stopped to display, draw and show any necessary materials on the topics as teaching aid where the need arises. The teaching of both experimental group and control groups was guided by the lesson plan. For details of lesson plans for both experimental and control groups (see Appendixes 8 & 9).

3.6.4 Procedure for Data Collection

Immediately after six weeks period of treatment, a posttest was administered to both the subjects in the experimental and control groups with the CPAT, CPPT and CPAI. The CPAT was scored by the researcher using the carefully prepared and validated marking guide to ensure uniformity in scoring. While the CPPT was scored using the chemistry practical performance observation check list prepared by the researcher (see Appendix 3).

Ten research assistants were trained and pretested for the effective assessment of the students' practical skills using the check list. Since the students' skills was assessed while they were performing the practical in the laboratory and the number of the students involved were (100) doing the experiment at the same time. The subjects were divided in to (10) sub-groups made up of (10) members per group and each group was assigned a research assistance who monitored and scores the students' practical skills. The research instruments were personally administered by the researcher after marking and collation; the result was subjected for data analysis.

Finally, for the Chemistry Practical Attitude Inventory (CPAI), the researcher personally administered the questionnaire to the subjects in both the experimental and control groups. Furthermore explanations were given to the subjects on how to fill the sections of the questionnaire as required and they were allowed to ask questions for further clarifications.

3.7 Procedure for Data Analysis

The results and responses of the subjects obtained from the three research instruments CPAT, CPPT and CPAI were scored using the marking guide for each respectively, and the data collected was analyzed by re-stating the research questions and hypotheses. While the statistical tools used for the stated hypotheses at probability at $P \leq 0.05$ level of significance was used for retaining or rejecting the null hypotheses which are as follows:

Hypothesis 1: There is no significant difference in academic achievement between subjects taught practical chemistry concepts using conceptual instructional method and those taught same concepts using lecture method at senior secondary school level. *t*-test statistics was used to test this hypothesis.

Hypothesis 2 : There is no significant difference in academic achievement between male and female subjects after exposure to practical chemistry concepts using conceptual instructional method at senior secondary school level.

Hypothesis 3 : There is no significant difference in practical performance of subjects taught practical chemistry concepts using conceptual instructional method and those taught the same concepts using lecture method.

Hypothesis 4: There is no significant difference in practical performance between male and female subjects taught practical chemistry concepts using conceptual instructional method.

Hypothesis 5: The difference in attitude change between subjects taught practical chemistry concepts using conceptual instructional method and those thought same concepts using lecture method is not significant. Mann-whitney *U*-test was used to test this hypothesis.

Hypothesis 6: There is no significant relationship between academic achievement and practical performance of subjects taught practical chemistry concepts using conceptual instructional method. Pearson' Product Moment Correlation Coefficient (PPMC) was used to test this hypothesis.

CHAPTER FOUR

DATA ANALYSIS, RESULTS AND DISCUSSION

4.1 Introduction

In this chapter, the results obtained and analyses of the data collected were presented. The data were analysed using the Statistical Package for Social Science (SPSS), and the level of significance adopted for rejecting or retaining a stated hypotheses was 0.05.

The chapter also contains discussion of the results and summary of the findings from the results presented. The instruments used for data collection were:

(1) Chemistry Practical Achievement Test (CPAT) which was used to measure the subjects' academic achievement in the pretest and posttest for both experimental and control groups.

(2) Chemistry Practical Performance Test (CPPT) which was used to measure the subjects' practical skills in the pretest and posttest for both experimental and control groups.

(3) Chemistry Practical Attitude Inventory (CPAI); which was used to measure the change in attitude of the subjects in pretest and posttest for both experimental and control groups.

The data obtained in the course of the study were:

(1) Chemistry Practical Achievement scores for both subjects in the experimental and control groups.

(2) Chemistry Practical Performance scores for both subjects in the experimental and control groups.

(3) Chemistry Practical Attitude Inventory for both subjects in the experimental and control groups.

4. 2 Data Analysis and Results

The results obtained from the data analysis are presented in Tables 4.1 to 4.12 and was used to test the stated hypotheses:

Research Question One: What is the difference in academic achievement of subjects taught practical chemistry concepts using conceptual instructional method and those taught using the lecture method at senior secondary school level?

Answer to Research Question One:

The answer to research question one is summarised in Table 4.1

Table 4.1: Academic Achievement posttest mean scores of the Subjects in the Experimental and Control group.

Groups	N	$\overline{X}$	S.D	mean diff
Experimental	50	33.06	8.610	5.16
Control	50	27.90	8.617	

There is a significant mean difference of 5.16 in academic achievement of the subjects taught chemistry practical concepts using conceptual instructional method and their counterparts who were taught the same concepts using the lecture method of instruction. With experimental group having mean scores of 33.03 while that of the control group is 27.90.

Null hypothesis one: There is no significant difference in academic achievement between subjects taught practical chemistry concepts using conceptual instructional method and those taught using the lecture method at senior secondary school level.

To test this hypothesis, the posttest scores of the subjects in the experimental and control groups were compared using t-test statistics. The result obtained is shown in Table 4.2

Table 4.2: Comparison of the Academic Achievement Posttest mean Scores of the Subjects in the Experimental and Control Groups

Groups	N	$\overline{X}$	S.D	S.E	Df	*t*-value	*p*-value	Remarks
Experimental	50	33.06	8.610	1.218	98	2.775	0.008	Significant
Control	50	27.90	8.617	1.219				

Significant at $p \leq 0.05$

The data in Table 4.2 shows that, the *p*-value obtained is 0.008 at $p \leq 0.05$ level of significant. The p-value of 0.008 obtained is thus significant as it is less than 0.05 level of significance set for the research. The null hypothesis of no significant difference is thus rejected. This means that there is significant difference in the academic achievement of the subjects in experimental and control groups. The result thus shows that; the conceptual instructional method seems to be more effective in improving students' academic achievement in the chemistry practical concepts than the lecture instructional method. It implies that, the subjects taught using conceptual instructional method achieved significantly better than those taught using the lecture method of instruction. Furthermore, the mean score value of 33.06 for experimental group and 27.90 for the control group further confirms this. Therefore the null hypothesis is thus rejected.

Research Question Two: Is there any difference in academic achievement between male and female subjects taught practical chemistry concepts using conceptual instructional method at senior secondary school level?

Answer to Research Question Two:

The answer to research question two is summarised in Table 4.3

Table 4.3: Academic Achievement Posttest Mean Scores of male and female Subjects in the Experimental Group

Groups	Gender	N	$\overline{X}$	S.D	mean diff
Experimental	Male	25	31.00	7.605	0.64
	Female	25	30.36	9.242	

There is no significant mean difference of 0.64 in the academic achievement between male and female subjects taught chemistry practical concepts using the conceptual instructional method. This is indicated in Table 4.2 with male subjects having mean scores of 31.00 which is similar with those of the female subject with mean scores of 30.36.

Null hypothesis two: There is no significant difference in academic achievement between male and female subjects after exposure to practical chemistry concepts using conceptual instructional method at senior secondary school level.

Table 4.4: Comparison of the Academic Achievement Posttest Mean Scores of male and Female Subjects in the Experimental Group

Groups	Gender	N	$\overline{X}$	S.D	S.E	Df	*t*-value	*p*-value	Remarks
Experimental	Male	25	31.00	7.605	1.521	48	1.727	0.097	Not Significant
	Female	25	30.36	9.242	1.848				

Not significant at $p \leq 0.05$

The data in Table 4.4 shows the results of posttest scores for male and female subjects in experimental group and the p-value obtained is 0.097 which is greater than 0.05 p-level of significant at df of 48. Thus the null hypothesis is therefore retained. This indicates that; there is no significant difference in the achievement scores of male and female subjects when taught practical chemistry concepts using conceptual instructional method. The result also shows that the mean achievement score of male subject is 31.00 while the mean achievement scores of female subject is 30.36 which implies that the conceptual instructional method has not brought any significant difference in the achievement of male and female subjects in practical chemistry. This therefore means that the conceptual instructional method which was used for instruction with the experimental group is gender-friendly, since both gender equally benefit from the method thus the null hypothesis of no significant difference is retained.

Research Question Three: What is the difference in the practical performance of subjects taught practical chemistry concepts using conceptual instructional method and those taught using lecture method at senior secondary school level?

Answer to Research Question Three:

The answer to research question three is summarised in Table 4.5

Table 4.5: Practical Performance of the Posttest mean Scores of the Subjects in the Experimental and Control group

Groups	N	$\overline{X}$	S.D	mean diff
Experimental	50	34.12	10.95	7.26
Control	50	26.86	7.14	

There is a significant mean difference of 7.26 in the practical performance of the subjects taught chemistry practical concepts using conceptual instructional method and their counterparts who were taught the same concepts using the lecture method of instruction. The subjects in the experimental group have the mean scores of 34.12 while those in the control group have 26.86 as shown in Table 4.5.

Null hypothesis three: There is no significant difference in practical performance of subjects taught practical chemistry concepts using conceptual instructional method and those taught the same concepts using lecture method.

Table 4.6: Comparison of Practical Performance of the Posttest mean Scores of the Subjects in the Experimental and Control group.

Groups	N	$\overline{X}$	S.D	S.E	df	*t*-value	*p*-value	Remarks
Experimental	50	34.12	10.95	1.55	98	3.94	0.008	Significant
Control	50	26.86	7.14	1.01				

Significant at $p \leq 0.05$

In Table 4.6 at df 98, the calculated *t*-value and *p*-value at $p \leq 0.05$ are 3.94 and 0.008 respectively. The calculated p-value being lower than $p \leq 0.05$ set to determine the level of significance. This means that there is significance difference in the practical performance between the subjects in experimental and control groups. It implies that, the subjects taught using conceptual instructional method performed significantly better than those taught using the lecture method of instruction. This is also shown from the mean scores 34.12 for the subjects in the experimental group which is higher than mean scores values 26.86 for the subjects in the control group. Thus, there is statistically significant difference in the practical performance of SSII chemistry students exposed to conceptual instructional method and those exposed to lecture method. Therefore the null hypothesis is rejected.

Research Question Four: Is there any difference in the practical performance between male and female subjects taught practical chemistry concepts using conceptual instructional method at senior secondary school level?

Answer to Research Question Four

The answer to research question four is summarised in Table 4.7

Table 4.7: Practical Performance of the posttest mean scores of male and female subjects in the Experimental Group

Groups	Gender	N	$\overline{X}$	S.D	mean diff
Experimental	Male	25	35.76	12.252	6.44
	Female	25	29.32	9.137	

There is a significant mean difference of 6.44 in the practical performance between male and female subjects taught chemistry practical concepts using the conceptual instructional method in favour of male subjects as shown in Table 4.7, with male subject having mean scores of 35.76 while the female subjects have 29.32.

Null hypothesis four: There is no significant difference in practical performance between male and female subjects taught practical chemistry concepts using conceptual instructional method.

Table 4.8: Comparison of Practical Performance of the posttest mean scores of male and female in the Experimental Group

Groups	Gender	N	$\overline{X}$	S.D	S.E	Df	*t*-value	*p*-value	Remarks
Experimental	Male	25	35.76	12.252	2.450	48	2.081	0.048	Significant
	Female	25	29.32	9.137	1.827				

$p \leq 0.05$ level of significance

Table 4.8 shows the results of the posttest scores for the male and female subjects in experimental group, the p-value obtained is 0.048 at $p \leq 0.05$ level of significance which indicates that there is a significant difference in the practical performance of the male and female subjects taught practical chemistry concepts using conceptual instructional method. This indicates that the male students performed significantly better than their female counterparts and therefore the null hypothesis is rejected.

Research Question Five: What is the change in attitude of subjects taught practical chemistry concepts using conceptual instructional method and those taught using lecture method?

Answer to Research Question Five

The answer to research question five is summarised in Table 4.9

Table 4.9: Attitude Change of the Subjects in the Experimental Group

Groups	N	Mean Rank	Sum of Ranks	mean diff
Experimental	50	69.69	3484.50	
				38.38
Control	50	31.31	1565.50	

There is a significant mean rank difference of 38.38 in the attitude change of subjects taught chemistry practical concepts using conceptual instructional method in the experimental group and those taught same concepts using lecture method of instruction in the control group as shown in table 4.9 with the subjects in the experimental group having mean rank of 69.69 while that of the control group is 31.31.

Null hypothesis five: The difference in attitude change between subjects taught practical chemistry concepts using conceptual instructional method and those thought same concepts using lecture method is not significant.

Table 4.10: Comparison of the Attitude Change of the Subjects taught using Conceptual Instructional Method.

Groups	N	Mean Rank	Sum of Ranks	Mann-whitney U-test	P	Remarks
Experimental	50	69.69	3484.50			
				290.500	0.00	Significant
Control	50	31.31	1565.50			

Significant at $p \leq 0.05$ level

In Table 4.10, the p-value of 0.00 was obtained which is lower than $p \leq 0.05$ level of significant set for the research and the mean rank values of 69.69 for the subjects in the experimental group is higher than 31.31 for those in the control group. This indicates that subjects exposed to conceptual instructional method shows more positive attitude towards practical chemistry than those exposed to lecture method of instruction. It also implies that there is significant difference in the attitude change of the subjects to the learning of chemistry practical concepts using conceptual instructional method therefore the null hypothesis is thus rejected.

Research Question Six: Is there any relationship between academic achievement and practical performance of subjects taught practical chemistry concepts using conceptual instructional method and those taught using lecture method at senior secondary school level?

Answer to research Question Six

The answer to research question six is summarised in Table 4.11

Table 4.11: Relationship between Academic Achievement and Practical Performance Scores of Subjects in the Experimental

Groups	Variables	N	$\overline{X}$	S.D	mean diff
Experimental	Achievement	50	27.90	8.617	1.04
	Performance	50	26.86	7.137	

There is a significant mean different of 1.04 in relationship between academic achievement and practical performance of subjects taught chemistry practical concepts using conceptual instructional method in experimental group. This is shown in Table 4.11 where the mean scores for academic achievement is 27.90 while that for the practical performance is 26.86

Null hypothesis six: There is no significant relationship between academic achievement and practical performance of subjects taught chemistry practical concepts using conceptual instructional method.

Table 4.12: Comparison of the Relationship between Academic Achievement and Practical Performance scores of subjects in the experimental

Groups	Variables	N	$\overline{X}$	S.D	S.E	Df	*r*-value	*p*-value	Remarks
Experimental	Achievement	50	27.90	8.617	1.219	49	0.398	0.004	Significant
	Performance		26.86	7.137	1.009				

At $p \leq 0.05$ level of significant

The results in Table 4.12, shows that; there is significant correlation in posttest academic achievement scores and practical performance scores of the subjects in the experimental group this is because p-value of 0.004 was less than the $p \leq 0.05$ level of significant set for the study . Thus, there is a significant relationship between students' academic achievement and practical performance, which is an indication that students' with high achievement equally performed well in practical.

This implies that the subjects in the experimental group that have high score in their academic achievement, which involved cognitive domain also have high scores in the practical performance which involved psychomotor domain. Therefore conceptual instructional method enhances both domains of knowledge. Therefore the null hypothesis is thus, rejected for the experimental group.

4.3 Summary of Findings

In the course of this study, the following findings were made:

1. The academic achievement of the subjects taught chemistry practical concepts using conceptual instructional method was higher than their counterparts who were taught the same concepts using the lecture method of instruction.

2. There is no significant difference in the academic achievement between male and female subjects taught chemistry practical concepts using the conceptual instructional method.

3. When the practical performance of the subjects in the experimental and control was compared, the subjects in the experimental group performed significantly better.

4. male subjects in experimental group performed significantly better than their female counter parts in the same group.

5. There is a positive change in attitude of the subjects taught chemistry practical concepts using conceptual instructional method in the experimental group compared to those taught same concepts using lecture method of instruction in the control group.

6. There is a correlation between academic achievement and practical performance of subjects taught chemistry practical concepts using conceptual instructional method in experimental group.

4.4 Discussion of Results

The aim of this study was to investigate the influence of conceptual instructional method on students' performance in, and attitude towards practical chemistry among senior secondary school students. To achieve this aim, subjects in the experimental group (EG) were taught chemistry practical concepts using conceptual instructional method. Subjects in the control group (CG) were taught the same chemistry practical concepts, using the lecture method of instruction. Tennyson and Cocchiarella (1986) model of concept teaching was used to teach the subjects in the experimental group. The subjects (EG) were then post tested and their academic achievements, practical performance and attitude change in practical chemistry were compared to that of the control group (CG) according to the variable being measured.

Table 4.2 showed a significant difference in the pos-test achievement mean scores of the experimental and control groups. The experimental groups achieved significantly higher than their counterparts in the control group. This finding is in line with that of Clark (2003) in a similar study which indicated that; students exposed to conceptual instructional approach achieved better than their counterparts. The superiority of conceptual instructional method over the lecture method was also reported by Jordi (2010) who conducted a research on the development of conceptual instruction and traditional instruction in chemistry and find that; those taught with conceptual instructional method performed better than those taught using the traditional method of instruction. Birbili (2007) in a similar study, attempted to organize teaching and learning in early childhood education around concepts and generalization rather

than inert facts. He stressed that teachers can facilitate concept development by putting concepts and generalizations at the centre of activities that provides the children with a wider range of concrete experiences and in a way helping them learn to observe and represent better what they see and hear. In the same study Birbili (2007) stressed that with concept based instruction, the learners performed better. A contrary result was obtained by Douglas (1997) in his research on the effect of explicit problem-solving and conceptual instruction in physics. The result indicated that, there was no overall difference between the two groups.

In this research, the significant difference in favour of the experimental group suggests a greater effectiveness of the conceptual instructional method which was used to teach the subjects in the experimental group due to the fact that, concepts are linked with prior knowledge which makes them more meaningful and more embracing. The superior success of the subjects in the experimental group over their counterparts in the control group could be explained by the fact that, conceptual instructional method enhances the understanding of concepts in practical chemistry as suggested by (Tennyson & Chocchiarella, 1986).

Table 4.4 indicated that; the male and female subjects in experimental group showed no significant difference in achievement. This means that there is no significant difference in the academic achievement between male and female subjects taught chemistry practical concepts using conceptual instructional method.

Therefore this means that; conceptual instructional method used and the achievement of the subjects is gender friendly. The result is in support of the findings of Ogunboyede (2003) who conducted a research comparing the academic achievement of boys and girls at primary school level. The findings indicated that; boys are not better than girls in terms of educational achievement. Also a research conducted by Iorchugh (2006) on the influence of cognitive style, cognitive level and gender on students' achievement in physics did not find

either gender performing better. Shaibu and Mari (1994) in their findings on the effect of gender performance on integrated process skills, found out that female subject were significantly better than their male counterparts and that there was a significant difference between the male and female subject in their ability to solve quantitative problems.

In this research there is no difference in academic achievement in male and female subjects due to the fact that, they are both exposed to same concepts, under the same condition by same teacher using the same method of instruction, therefore conceptual instructional method is gender friendly. Less emphasis on gender and gender-bias treatment of male and female seems to be bridging the gender gap in learning between male and female

The results in Table 4.6 showed a significant difference in the mean scores of the subjects in the experimental and control groups. The subjects in the experimental group performed significantly higher than their counter parts in the control group. A similar research was conducted by Sevgi, Nurdane, Yezdan, Ayla and Octlay (2009) in which they evaluated whether a chemistry laboratory course called "Laboratory experiments in science education" based on constructivist instruction enhanced pre-service chemistry teachers' conceptual understanding or not. Results shows that pre-service teachers had good conceptual understanding about practical chemistry, also using constructivist instruction as instructional tools was effective in promoting conceptual understanding.

The result is also in line with that of Domin (2007) who reported that, the students who were exposed to practical work in the laboratory using conceptual instructional method, performed better than those taught using the traditional method of teaching.

The significant difference in favour of the experimental group suggests a greater effectiveness of the conceptual instructional method which was used to teach the subjects in the experimental group. The superior success of the subjects in the experimental group over their counterparts in the control group, could be explained by the fact that the subjects in the

experimental group received training in chemistry practical in such a way that they understand the concepts behind the practical chemistry using their pre requisite knowledge and the concepts were subsequently developed as suggested by Tennyson and Chocchiarella (1986), which assist to enhance the practical skills of the subjects in the experimental group. On the other hand, this is in contrast with the students in the control group who were taught the same concepts using lecture method of instruction.

Table 4.8, it was observed that there is a significant difference in the practical performance of male and female subjects taught chemistry practical concepts using conceptual instructional method, therefore the null hypothesis is rejected. This finding is in line with that of Arbogast (1997) who suggest that female students due to their feminine nature can withstand only moderate stress. It is also in line with the findings of Krough and Thomsen (2000) who concluded that Danish boys performed a little better than girls in chemistry but girls are a little more interested in chemistry than boys.

The finding also contradict the study made by Philips (2006) who opined that girls excel consistently at arithmetic computation and are superior in reading and hand writing and that of Danladi (2003) whose study revealed no significant difference in achievements between boys and girls involving process skills acquisitions. Which is also contrary with the findings of Lakpini (2006) and Lawal (2009).

Research has shown that, male subjects have better manipulative skills than their female counterparts. Also in this research it is shown that, male subjects performed significantly better than their female counterparts. This may be due the high stress involved in the manipulation of the apparatus during the practical activities as males are able to cope with stressful experiences more than females due to their superior physical and emotional stability over females.

Table 4.10 revealed a significant difference in attitude change of subjects taught chemistry practical concepts using conceptual instructional method and those taught using the lecture method of instruction. The p-value of 0.00 at 0.05 level of significant which is far less than the P-statistics set for the research, further confirms a significant difference between the subjects in the experimental and the control groups. This attitudinal change can be attributed to the strategy used for the teaching. Olorukooba (2001) used cooperative instructional strategy which is also activity based, to teach chemistry students.

The result revealed that students developed positive attitude by engaging in group work, the attitude expressed by the subjects in the experimental group can be described as being favourable due to the educational benefits the subjects derived from the instructional strategy. Conceptual understanding enhances performance which creates interest, positive attitude and desire to participate in classroom activities. These benefits include: conceptual understanding which leads to improvement in the academic achievement and practical performance of the subjects in the experimental group.

Table 4.12 shows that there is a significant relationship in the academic achievement and practical performance of the subjects in the experimental group experimental group (EG) with a p-value of 0.004 which is less than 0.05 level of significant set for the research . Therefore the null hypothesis is rejected.

This finding is in line with the study conducted by Aina (2012) whose findings indicated that theory and practical physics were significantly related but there was no significant relationship in students' performance based on gender. The study is also in line with the findings of Usman (2000) who found a positive relationship between students' performance in practical activities and their academic achievement in integrated science using NISTEP mode of teaching. It is also in line with the study conducted by Aina (2012) whose findings indicated that theory and practical physics were significantly related.

The findings from this study shows that, there is a significant relationship between academic achievement and practical performance in chemistry, therefore subjects with good scores in practical performed better in chemistry than those with low scores.

Thus, good practical knowledge generally enhances performance in chemistry. Therefore chemistry practical achievement test (CPAT) was used to test the cognitive ability of the subjects while chemistry practical performance test (CPPT) was administered to test for the psychomotor skills, which implies that, understanding the concepts in practical chemistry will assist in effective use of practical skills while conducting the practical.

The implications of all the issues outlined above, means a radical change from the traditional method of learning which is characterised by factual and rote learning to a more effective and meaningful learning theory that is rapidly gaining ground known as constructivism. Conceptual instructional method is suggested in this study, as it yields permanent and meaningful learning whose products are understanding and retention.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

In this chapter, the objectives of the study, the methodology employed to collect data and the summary of the findings are briefly highlighted. The conclusions emanating from the findings and requisite recommendations are outline. The chapter ends with the highlights of the limitations of the study and suggestions for further studies.

5.2 Summary of the Study

This study investigated the Influence of Conceptual Instructional Method on Students' Performance in, and Attitude towards Practical Chemistry at Senior Secondary School Level in Zaria Educational Zone Kaduna State Nigeria. Tennyson and Chocchiarella (1986) model of concept teaching was used to teach chemistry practical concepts to the subjects in the experimental group while the control group were taught the same concepts using lecture method. The research also investigated the effects of gender-related differences on students' academic achievement and their practical performance in chemistry practical concepts when exposed to conceptual instructional.

The target population for the study was 1401 S.S. II Science Students. A sample of 100 Students was randomly drawn from two co-educational senior secondary schools, within Zaria educational zone. The subjects were divided in to two groups: The experimental group and the control group of 50 students each. The pretest-posttest quasi-experimental control group design was adapted. The subjects in the experimental group were exposed to Conceptual Instructional Method, while those in the Control group were exposed to the lecture instructional strategy for a period of six weeks. The following instruments were developed and validated for data collection: Chemistry Practical Achievement Test (CPAT)

with reliability coefficient of 0.71, Chemistry Practical Performance (CPPT) with reliability coefficient of 0.73 and Chemistry Practical Attitude Inventory (CPAI) with reliability coefficient of 0.79. Six research questions were stated and six null hypotheses were tested. The data collected were subjected to statistical analysis at 0.05 level of significance. *t*-test statistics was used to test the hypotheses on achievement, performance and gender difference. Mann-Whitney *U*-test was used to test the subjects change in attitude towards practical chemistry while Pearson product moment correlation coefficient *r*- statistic was used to test the relationship between academic achievement and practical performance in the experimental group. The major findings from the study include the following: The Academic Achievement, Practical Performance and Attitude change of subjects exposed to Conceptual Instructional Method were significantly higher than their counterparts exposed to lecture method of instruction. With reference to gender, there was no significant difference between male and female students academic achievement in the experimental group but, for practical performance there was a significant difference between male and female students practical performance with the male students performing better than their female counterparts. It was also found that, there is a significant relationship between academic achievement and practical performance of subjects in the experimental group. On the basis of the findings outlined above, it was concluded that, conceptual instructional method enhances senior secondary school students' academic achievement, practical performance and attitude towards practical chemistry.

5.3 Summary of Major Findings

(1) The subjects exposed to conceptual instructional method achieved significantly higher in chemistry practical concepts than their counterparts exposed to lecture method of instruction.

(2) There was no significant difference in the subjects' academic achievement of male and female subjects taught chemistry practical concepts using conceptual instructional method

(3) The practical performance of subjects taught chemistry practical concepts using the conceptual instructional method is significantly higher than those taught the same concepts using the lecture method of instruction.

(4) There was a significant difference in the practical performance of male and female subjects taught practical chemistry using conceptual instructional method.

(5) There was a significant difference in the attitude change of the subjects taught practical chemistry concepts using conceptual instructional method and those taught using lecture method.

(6) There was a significant relationship between academic achievement and practical performance of subjects taught chemistry practical concepts using conceptual instructional method.

5.4 Conclusions

Based on the findings from this study, the following conclusions are drawn:

a. Conceptual instructional method enhances academic achievement, practical performance as well as attitude of senior secondary school students towards practical chemistry. Therefore conceptual instructional method is viable and has potential to enhance senior secondary school students academic achievement in chemistry and promote acquisition of practical skills.

b. The teaching of practical chemistry, using conceptual instructional method, was found to be gender friendly. This means that, both male and female students equally benefit in conceptual instructional strategy.

c. Academic achievement and practical skills performance correlate highly and this could be an indication that teaching practical chemistry through conceptual instructional method could increase both acquisition of practical skills and academic achievement in chemistry.

5.5 Recommendations

On the basis of the findings and conclusions reached, the following recommendations are made:

1. This study shows that, conceptual instructional method enhanced students' academic achievement, practical performance and attitude towards practical chemistry compared to lecture method. Use of conceptual instructional method by chemistry teachers should therefore be encouraged in Nigerian secondary schools.

2. It is recommended that teacher training colleges, universities and educational institutions should incorporate conceptual instructional method in their curricular at all levels. This will ensure the development of its knowledge for the teachers on training.

3. Professional associations like; the Science Teachers Association of Nigeria (STAN), Chemical Society of Nigeria (CSN) and Research Centres such as Nigerian Educational and Research Development Council (NERDC), should incorporate conceptual instructional method in their science curricular at senior secondary school level to encourage the use of the strategies among teachers and they should also organise seminars and workshops for the teachers on how to use the conceptual instructional method to teach chemistry and science in general.

4. Since the strategy is gender friendly, it could serve as effective instructional strategy in both single sex and co-educational schools.

5.6 Contributions to Knowledge

This study has established that:

1. When conceptual instructional method is used to teach chemistry practical concepts, students tend to understand the concepts better and perform appreciably well in practical chemistry
2. The use of Conceptual Instructional method tends to bridge the gap of gender difference in academic achievement between male and female subjects. But in case of practical performance, male subjects perform better than their female counter parts.
3. The study established a positive relationship between students' academic achievement and their practical performance in chemistry practical.

Limitations of the Study

The study has some limitations which include the following:

1. The restrictions of the study to only two senior secondary schools in Zaria Educational Zone of Kaduna state, made the scope of generalizations that can be made from the study fairly narrow.

2 The researcher found it difficult to stick to the time because most of the students came late, consequently the lesson started late and ends late.

5.7 Suggestions for Further Studies

The following suggestions are made to further expands the scope of this study:

1. A similar study should be carried out focusing on the teaching of other science subjects using the conceptual instructional method with a view of finding out if similar or different results as in this study might be obtained.
2. There is need to extend the population to other secondary schools in other local government councils in Kaduna State and other States of Nigeria to make wider generalization.

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APPENDIX 1:

DEPARTMENT OF SCIENCE EDUCATION,

AHMADU BELLO UNIVERSITY ZARIA,

CHEMISTRY PRACTICAL ACHIEVEMENT TEST *(CPAT)*

Instructions: ANSWER **ALL** questions in sections **'A'&'B'** in ***ink*** TIME**: *2hours***

SECTION 'A'

Burette readings (initial & final) ***should*** be given to two decimal places. Volume of pipette used ***should*** also be recorded but **no account** of experimental procedures is required. *All calculations* ***should*** be done in the ***ANSWER BOOKLET provided.***

Q1. 'A' is 0.100 $moldm^{-3}$solution of an acid; **'B'** is a solution of KOH containing 2.8g per $500cm^3$.

(a) Put **'A'** into the burette and titrate it against 25.0 cm^3 portion of **'B'** using methyl orange as indicator. Repeat the titration to obtain relatively consistent titres. Tabulate your readings and calculate the:

(i) number of moles of acid in the average titre;

(ii) number of moles of KOH in the volume of **'B'** pipetted;

(iii) mole ratio of acid to base in the reaction.

[H=1.00, O=16.0, K=39.0]

SECTION 'B'

Q1. If $10.0cm^3$ of distilled water is added to $0.02moldm^{-3}$ solution of a base before the titration commences, what will happen to the concentration of the base?

Q2. An acid solution is known to contain 0.0005moles of the acid in $250cm^3$ how can you prepare $1dm^3$ of the acid solution containing X number of moles?

Q3. An orange juice was extracted and used to titrate a solution of $0.01moldm^3$ NaOH. Which indicator could be best used for the titration and why?

Q4. A student was carrying out titration using strong acid and strong base. About $5.0cm^3$ distilled water was mistakenly added to the titration mixture. Will it affect the endpoint of the titration? Give reasons for your answer.

Q5. 0.01mole of NaOH was dissolved in just enough water and made up to $1.0dm^3$. If $25.0cm^3$ of the solution is removed, what will happen to the concentration of the remaining 1Zsolution in the flask?

Q6. A reaction between $Ag^{+}_{(aq)} + Cl^{-}_{(aq)} \longrightarrow AgCl_{(crystals)}$ is called precipitation reaction.

What name will you give to a reaction between Calcium hydroxide solution and hydrochloric acid?

Write a balanced equation for the reaction

Q7. Five students each were given 0.1mola HCl solution to titrate against 25.00cm^{3}of 0.1molar NaOH solution. The students obtained the following titration results:

Students	1	2	3	4	5
Titre values in (cm^3)	25.10	25.12	25.20	26.21	25.03

State two reasons for the high titre values obtained by student 4

Q8. An eye-dropper is calibrated such that; 20 drops are required to deliver 1.0 cm^3. What will be the volume of just one drop?

Q9. The calculated mass of sodium hydroxide pellets in 200cm^3 of 0.10moldm^{-3} solution was found to be 0.8g. The solution is then transferred to 500cm^3 volumetric flask and it was filled to the mark with distilled water. What will be the actual mass of sodium hydroxide in the new container?

Q10. A student carried out titration using 0.05moldm^{-3} trioxonitrate (v) acid against potassium hydroxide solution. He found out the conc. of the base to be 0.05moldm^3. He was then instructed to add 10.0cm^3 of the base into the titration mixture. Explain the changes that will occur in pH of the solute

APPENDIX 2:

MARKING GUIDE FOR (CPAT)

SECTION 'B'

d. Though the base is diluted, the number of moles of is unaffected so the concentration of the base will remain the same. ***(3marks)***

e. Since 0.0005moles of the acid solution placed in ⟹ $250cm^3$

Therefore the same X moles will contain ⟹ $1000cm^3$ ($1dm^3$)

$$\text{Cross multiply, } X = \frac{0.0005 \times 1000}{250}$$

Therefore the volume of $1dm^3$ will contains = 0.002 moles

f. The suitable indicator to be used for such titration is phenolphthalein since the acid extracted from plants is said to be weak acid and NaOH solution is a strong base.

g. Addition of distilled (de-ionised) water to the titration mixture will not affect the titre value. This is because the base in the conical flask has consumed the number of moles of the acid and reach its equivalent points therefore adding distilled water will not affect the titration result.

h. The concentration of the remaining sodium hydroxide solution in the flack will remain unchanged, but its only the volume will decrease since $25.0cm^3$ is removed out of $1dm^3$ of the solution.

i. Such reaction is called neutralization reaction, since it involved a reaction between strong base [$Ca(OH)_2$]and a strong acid [HCl].

$$Ca(OH)_2(aq) + 2HCl(aq) \longrightarrow CaCl_{2\,(aq)} + 2H_2O(l)$$

j. The reasons for the high titre value obtained by student 4, it could be that he :

(i) He rinsed the conical flask with aqueous solution of base which leads to the increase in the volume of the base required for neutralization to occur.

(ii) Was unable to filled up the pipette with the base or the burette with acid to the meniscus level correctly.

k. Since 20drops from the dropper can deliver ⟹ 1.0 cm^3

Therefore 1drop will deliver ⟹ X.0 cm^3

Cross multiply, 20 drops x X.0cm^3 = 1drop x1.0 cm^3

$$X = \frac{1.0\ cm^3}{20.0}$$

Therefore the volume of 1drop = 0.05 cm^3

l. If 0.8g 9initial mass) of NaOH dissolved in ⟹ 200cm^3

Let 'X' be the actual mass of the NaOH in new volume ⟹ 500cm^3

By cross multiply, X.0g x 200cm^3 = 0.8g x 500cm^3

$$X = \frac{400}{200}$$

X =2.0g

Therefore the actual mass of NaOH in the new volume = 2.0g

Since there is an increase in the number of moles of the base in the titration mixture, therefore there will be a great change in the pH of the solution from 7.0 neutral at the titre values to pH value greater than 7-14 maximum level.

APPENDIX 3:

CHEMISTRY PRACTICAL PERFORMANCE TEST *(CPPT* Observation Check List)

The main purpose of this observation checklist is to assess and evaluate students' activities in volumetric analysis (titration) in practical chemistry laboratory session.

Each correct practical skill will be ticked accordingly. The scores are as follows:

Very good = 3marks, good = 2marks fair = 1mark and poor = 0 mark

SN	ITEM	SCORE 3	2	1	0
1.	Correct assembling of the apparatus required for the titration				
2.	Washing the burette with water, rinsing it with acid solution and allowing it to drain				
3.	Clamping the burette firmly in a correct vertical position				
4.	Manipulating the burette tap using the left hand thumb, index and middle finger in a clockwise direction.				
5.	Testing the tap to ensure that it is not leaking				
6.	Closing the tap of the burette, and then pouring the acid solution using a funnel				
7.	Removing the funnel from the burette immediately				
8.	Opening the burette tap to expel air bobbles				
9.	Using a dark paper when viewing the meniscus in the burette in order to obstruct reflections				
10.	Viewing accurately the burette reading with eye level parallel to the lower part of the meniscus while filling with acid				
11.	Washing the pipette with water and rinsing with a base solution and allowing to drain				
12.	Inserting the tip of the pipette correctly at angle 60^{o} into the beaker to suck the solution of the base until it just passes the mark on the pipette				
13.	Using the dry index finger tip as the stopper, and allowing the base solution to run out of the pipette by accurately releasing the finger pressure until the lower meniscus falls on the mark, while holding the pipette in an upright position				
14.	Allowing the solution of the base to run into the conical flask correctly by				

removing the finger tip without spillage

15. Accurate delivery of the exact volume by inserting the tip of the pipette inside the conical flask

16. Adding maximum of two drops of indicator in to the centre of the conical flask without allowing it to touch the walls of the flask
17. Placing the conical flask containing the solution of the base under the burette on a white tile or any white surface
18. Running the acid solution gradually into the conical flask and swirling intermittently at the rate of 10 drops per second until the colour of the titration mixture changes
19. Identification of the endpoint when a flash colour is observed and addition of acid is stopped for a while then adding just a drop to obtain a permanent colour change of the titration mixture.
20. Dismantling the setup of the apparatus safely, deposing the remaining acid and base solution and rinsing the apparatus at the end of the titration

APPENDIX 4:

DEPARTMENT OF SCIENCE EDUCATION
AHMADU BELLO UNIVERSITY, ZARIA
CHEMISTRY PRACTICAL ATTITUDE INVENTORY

Dear Respondent, below are some questions meant to measure your opinions on your attitude towards practical chemistry at SSCE level. I will appreciate your contribution in filling the questionnaire objectively. It consists of sections **A** and **B**. You are to respond to both sections please. Kindly give your response correctly and objectively.
Your responses will be used only for research purposes.
Thank you:

SECTION (A) Respondent's Bio data

School ----------
Sex: **Male** ☐ **Female** ☐

SECTION (B) please tick appropriate column using the following keys**: -**

SA= Strongly agree, **A=** Agree**,** **U=** undecided, **D=** disagree, **SD=** strongly disagree respectively.

SN	ITEMS	A	SA	U	D	SD
1.	My teacher has been interested in my progress in practical chemistry					
2.	Practical chemistry is easy to me especially the theoretical aspect					
3.	The calculations aspect in volumetric analysis is interesting to					
4.	I think I could handle more difficult aspect of practical chemistry					
5.	Practical chemistry in qualitative analysis is enough to make me self-reliant.					
6.	I found theoretical questions in practical chemistry easy to under stand					
7.	I am doing practical chemistry because I know it is necessary for my future career					
8.	I know I can do well in practical chemistry					
9.	My teacher would take me serious if I told them I am interested in a career in practical chemistry					
10.	I am sure I could do advance work in practical chemistry					
11.	I study practical chemistry because I know how useful it is					
12.	I found volumetric analysis easy to under stand					
13.	The calculations aspect in volumetric analysis is interesting to me					

14. My teacher encourage me to study more of practical chemistry
15. I enjoy doing practical chemistry in group
16. I don't think I could do advance practical chemistry
17. Practical chemistry will not be important to me in my life's work
18. I fear coming contact with chemicals during practical
19. Practical chemistry is difficult for me
20. I have no interest in reporting practical work in chemistry
21. Chemistry practical concepts are confusing me
22. Chemistry practical in volumetric analysis is not interesting
23. Chemistry practical is hazardous that is why I hate it
24. Taking practical chemistry is a waste of time
25. Practical chemistry has been my worst part in understanding chemistry
26. I see practical chemistry as something I won't use very often when I get out of secondary school
27. I feel that my chemistry teachers ignore me when I try to talk about practical chemistry to them
28. Most science subjects I handle them very well, but I cannot do well in practical chemistry
29. Doing well in practical chemistry is not important for my future
30. Qualitative analysis in practical chemistry is not interesting
31. Poor performance by others in volumetric analysis makes me to dislike it.
32. I fear coming in contact with chemicals during practical chemistry

APPENDIX 5:

VALIDATION OF THE RESEARCH INSTRUMENTS

Department of Science Education
Faculty of Education,
Ahmadu Bello University Zaria,

The Lecturer,
Department of Chemistry,
Faculty of Science,
A.B.U Zaria.

Dear Sir,

VALIDATION OF A RESEARCH INSTRUMENT

I have developed a research instrument designed to generate data for my Ph.D thesis on teaching of practical chemistry concepts at senior secondary school level.

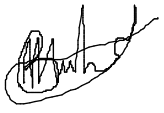
The instruments titled Chemistry Practical Performance Test (CPPT) and Chemistry Practical Achievement Test (CPAT) is drawn from the senior secondary school chemistry WAEC/SSCE syllabus and is to be used for both pretest and posttest. As an experienced chemistry teacher, inputs from you would certainly improve the quality of the instrument. Therefore I would like you to please examine the items with respect to the following:

1. Do the items relate to the practical chemistry concepts expected of senior secondary school students to comprehend?
2. Are the items readable, appropriate and up to standard?
3. Do the questions match the ability of the students?
4. What general criticisms and suggestions can you give for the improvement of the instrument?

I very much thank you and appreciate your assistance.

Thanks;

Your's sincerely,



MOHAMMAD BINTA ASABE.
Ph.D/EDUC/04868/08-09.

Department of Science Education
Faculty of Education
Ahmadu Bello University,
Zaria

The lecturer,
Mathematics Education section,
Department of Education
Faculty of Education,
A.B.U Zaria.

Dear Sir,

VALIDATION OF A RESEARCH INSTRUMENT

I have developed a research instrument designed to generate data for my Ph.D thesis on teaching of practical chemistry concepts at senior secondary school level.

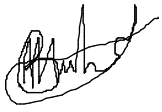
The instrument titled Chemistry Practical Achievement Test (CPAT) the items is drawn from the senior secondary schools chemistry WAEC/SSCE syllabus and is to be used for both pretest and posttest. The draft of the instrument is enclosed here with. As a specialist in statistics and research methodology. I would like you to examine the items with reference to the following:

1. Would the items of the instrument yield data relevant to the statistics to be used in data analysis?
2. Are the items clear, precise and free from ambiguity?
3. What general criticisms and suggestion could you give to improve the instrument?

I very much appreciate your assistance.

Thanks;

Your's Sincerely



MOHAMMAD BINTA ASABE.
Ph.D/EDUC/04868/08-09.

Department of Science Education,
Faculty of Education,
Ahmadu Bello University Zaria

The Lecturer,
Department of Educational psychology,
Faculty of Education,
A.B.U Zaria.

Dear Sir,

VALIDATION OF A RESEARCH INSTRUMENT

I have developed a research instrument designed to generate data for my Ph.D thesis on teaching of practical chemistry concepts at senior secondary school level. The instrument titled 'Chemistry Practical Attitude Inventory (CPAI). The draft of the instrument is enclosed here with. As a specialist in psychology and research methodology.
I would like you to examine the items with reference to the following:

1. Would these items test what they are meant to test?
2. What general criticisms and suggestion could you give to improve the instrument?

I very much appreciate your assistance.

Thanks.

Your's sincerely



MOHAMMAD BINTA ASABE.
Ph.D/EDUC/04868/08-09.

Department of Science Education,
Faculty of Education,
Ahmadu Bello University Zaria,
July; 2011.

The lecturer,
Department of English language,
Faculty of Arts,
A.B.U Zaria.

Dear Sir,

VALIDATION OF A RESEARCH INSTRUMENT

I have developed a research instrument designed to generate data for my Ph.D thesis on teaching of practical chemistry concepts at senior secondary school level.

The instrument titled Chemistry Practical Achievement Test (CPAT) is drawn from the senior secondary schools chemistry WAEC/SSCE syllabus and is to be used for both pretest for posttest. The draft of the instrument is enclosed here with. As a specialist in English-language. I would like you to examine the items with reference to the following:

1. Is the language expression used simple and unambiguous?
2. Are the items clear, precise and free from ambiguity?
3. Are they readable, appropriate and up to standard?
4. What general criticisms and suggestion could you give to improve the instrument?

I very much appreciate your assistance.

Thanks;

Your's sincerely



MOHAMMAD BINTA ASABE.
Ph.D/EDUC/04868/08-09.

APPENDIX 6:

RELIABILITY OF THE RESEARCH INSTRUMENTS

APPENDIX 7:

t-test **of the Pretest mean scores of Experimental and Control groups**

Groups	N	X	S.D	S.E	Df	*t*-value	*p*-value	Remarks
Experimental	50	33.36	8.406	1.681	49	1.727	0.869	Not Significant
Control	50	30.60	8.300	1.660	49			

Not significant at $P \leq 0.0\ 5$

APPENDIX 8:

Lesson plan for experimental group using Tennyson and Chocchiarella model of Concept teaching

UNIT I

Name of the teacher: Binta A. Mohammad

Regno: Ph.D/Educ/04868/2008-2009

Subject: Practical Chemistry

Topic: Acids and Bases

Class: SS II

Time: 1 hour

Instructional Materials: Lemon, a sample of inorganic Acid, litmus paper, beakers, water potash, ash, sodium hydroxide solution.

Concepts in the lesson:

i. ionization
ii. dissociation
iii. basicity of Acids
iv. neutralization

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

a. State the meaning of Acids and bases
b. Mention some sources of naturally occurring Acids and bases.
c. Give examples of Acids and bases
d. State the different types and strength of Acids and bases.

Rationale: Acids and bases are very important in chemistry especially during practical they are used both for qualitative and quantitative chemical analysis.

Lesson development (60 minutes)

Stage	**Teachers support**	**Learners activity**	**Learning points**
Step I Introduction 10 minutes Full class	Asks learners question about Acids and Bases e.g - what is an Acid - Give examples of Acids and bases. The teacher introduces the concepts by stating the properties of Acids and bases e.g Acids have; - sour taste - change blue litmus paper red - neutralizes base - release H_2 when reacted with a more electropositive metal While bases have; - bitter taste - are soapy - turn red litmus paper blue - neutralizes Acids - Concentrated forms of alkali are corrosive.	Respond to teacher's question, by defining what an acid is e.g; some said "acid is corrosive, others said its turned blue litmus paper red" The students listen to the teacher's explanation. On the properties of acid and bases	A general knowledge about concepts of acids and bases. Understand the properties of Acids and bases.
Step II Establishing a connection between Acids and bases to be learnt and the students existing knowledge	Based on the students' knowledge of Acids and bases, the teacher goes on to explain to the students that oranges are Acidic because they changes blue litmus paper red while potash is basic because it has bitter taste; sodium hydroxide is also a base while Sulphuric Acid is an Acid. Teacher asks students to test some of the substances like orange, bitter leaves, yoghurt and asks them to state the substances they are likely to contain	Think about their experiences with other Acid and basic substances based on the explanation given The teacher led students to realize that potash has bitter taste and unripe oranges taste sour.	Students were able to differentiate an Acid from a base.
Stage	**Teachers support**	**Learners activity**	**Learning point**
Step III Improvement in the formation of concepts	The teacher lead the students to understands the behaviour of acid in water and also defines the concept of Acid to the students as; Any substance or species having	Students listen to the teacher's explanation.	Students formed concepts of Acids and bases.

	tendency to donate a proton to water when they are mixed together. $HCl_{(aq)} + H_2O\ (l) \rightarrow H_3O^+_{(aq} + Cl_{(aq)}$ While a base is any substance which when dissolved in water produces hydroxyl ions. $2NaOH_{(aq)}+2H_3O^+_{(l)}\rightarrow 2Na^+_{(aq}+4OH^-_{(aq)} + H_{2(g)}$ The teacher associates the acid concepts with release of H_3O^+ in water and base with acceptance of H_3O^+.		
Step IV The teacher further facilities the development of concepts Group work	The teacher asks the learners to choose their leaders and secretary. The teacher asks the students to squeeze the juice from lime and taste it and further asks them to deep the red and blue litmus papers and record their observation. The students were further asked to dissolve the ash and potash provided in different beakers and use litmus papers to determine the colour of acids and basic solutions i.e HCl and NaOH solutions.	Learners choose their group leaders and secretary. Learners did exactly what the teacher asks them to do and recorded their result.	Sense of leadership. The students extend the concept of Acid to include change in colour with respect to both red and blue. Litmus papers.
Stage	**Teachers support**	**Learners activity**	**Learning point**
Step V Facilitates the Development of classification rule.	The teacher leads the learners to the concept of organic Acids and bases and explains that each fruit contain different type of acid e.g. ethanoic acid is present in vinegar. while citric Acid is presence in oranges and lemon. Organic acids and bases occur naturally in plants and animals, most of the fruits we eat contain Acids and the potash we use contains base. Organic acids contain carbon atom(s) in their molecules. While inorganic acids does not	Learners reflect on the concepts being taught and try to relate it to every day experience. Such as the difference in taste between vinegar & oranges.	Understand the concepts organic and inorganic Acids and bases.

	contain carbon atom in their molecules Inorganic Acids are called the mineral acids because they are synthesized from mineral ores e.g. HNO_3, HCl, etc. Teacher writes summary of the lesson to the learners. **Classes of acids** → Organic / Inorganic -Organic acids does not ionize completely in solution. $CH_3COOH \rightleftharpoons CH_3COO^- + H^+$ -Organic acids react with base to form soap while inorganic acid react with base to form salt and water. - Inorganic acids ionize completely in solution $HNO_3 \rightleftharpoons NO_3^- + H$	Learners note down the meaning of Acid and bases	Understand the concept Acids and bases.
Step VII Evaluation conclusion	Teacher asks questions to evaluate the achievement of the lesson - What are Acids and bases - What are the properties of Acids and bases - Give examples of Acid and bases	Learners summarize what they have done and learnt during the lesson.	Confirms the meaning characteristics, types and examples of Acids and bases.

UNIT II

Name of the teacher	Binta A. Mohammad
Reg No.	Ph.D /Educ/04868/2008-2009
Topic	Volumetric analysis
Class	SS II
Instructional materials :	Burettes, pipettes, Conical flasks, volumetric-flask, beakers, retort-stand/clamp, funnels, litmus-papers, dropping bottle, distilled water, methyl-orange, solutions of Acid and base.
Concepts in the lesson :	(i)end-point (ii) equivalent-point (iii) mole-ratio (iv)molar concentration (v) mass-concentration (vi) molarity (vii) molarity (ix)amount in mole (x) relative molecular mass (xi) Stoichiometric equivalent
Behavioural objectives :	By the end of the lesson, the students should be able to : (1) Explains the meaning of volumetric analysis (2) Explain what titration is (3) State the meaning of (a)end-point (b) equivalent-point (c) mole-ratio (d)molar concentration (e) mass-concentration (f) molarity (g) molarity (h)amount in mole (i) relative molecular mass (j) Stoichiometric equivalent (4) Explain the meaning of neutralization-point of a reaction.
Rationale :	
Previous knowledge :	Knowledge of volumetric analysis is fundamental basis for the study of practical chemistry at SSCE level it deals with the measurement of volumes of aqueous solution of reactants taking parts in a chemical reaction. Students have learnt about the use of litmus paper in testing Acids and bases and also the use of indicators in different reactions. Student have leant about the use of litmus paper in testing acids and bases and also the use of indicators in different reactions

LESSON DEVELOPTMENT (60 MINUTES)

Stages	Teacher support	Learners activities	Learning point
STEP I Introduction full class	Teacher introduces the lesson by asking the students some concepts in volumetric analysis such as: (1) what is neutralization? (2)how do you estimate quantities of a chemical substances in solution? (3) what is volumetric analysis? (4) explain what is meant by end-point of a reaction. (5) what happens when a solution of a base is added to dilute solution of acid of known concentration? (6) what happens when a solution of a known concentration of a base is added to dilute solution of acid of unknown concentration? Asks learners the use of the different apparatus in volumetric analysis.	Students respond to the teacher's questions. Learners observe the different apparatus and try to explain their uses.	Develop ideas for the objective of the lesson. The students understand the meaning of titration.
STEP II Establishing connection between concepts to be learnt and the students existing knowledge	Teacher explains to the students that volumetric analysis deal with quantitative measurement of volumes of aqueous solution of acids and bases to determine the actual volume of acid required to neutralize completely certain volume of base or vise-versa. The teacher further explains to the students that; a solution of every substance is a homogeneous mixture and as such, every accurate volumes of the solution taking contains same amount of substance dissolved in the solution i.e. every $20cm^3$ of solution in 20g of NaOH dissolved in it will contain same amount of NaOH. Thus, if substances react together, you can relate the amount of the		Sense of leadership Titration done practically using all the senses

	substances that will react by weighing their volume. If a solution is made by dissolving 40g of NaOH in 1000cm^3 of water. If 20cm^3 of the solution is taking, what will be the amount of NaOH in 20cm^3 of the solution taking?		
STEP III Group work improvement in the development of concepts.	The teacher asks the learners to choose their leaders and secretary. The teacher then, assists the students in each group by setting the apparatus for titration such as clamping the burette and using pipette to collect sample of the base among others.	Learners choose their leaders and secretary Learners did exactly what the teacher instructs them to do and go on with the titration process.	
Step IV Lesson development	The teacher goes on to explain to the students methods of preparation of a solution. Many chemical reactions involving volumetric analysis are carried out in aqueous solutions or as standard solutions. A standard solution can be prepared by two methods: Weighing & dilution methods. E.g (a) what mass of anhydrous Na_2CO_3 will be needed to prepare 0.10mole of it solution in 250.00cm^3 volumetric flask? The teacher explains to the students how to calculate the mass required as follows: Calculate the amount in moles first, If 0.1mole ⟶ 250cm^3 ? ⟶ 1000cm^3 =0.10mol/dm^3 X1000/250 = 0.4moles Convert amount in moles to mass in gram [molar mass of Na_2CO_3 where	The students were divided in to five groups and each group weighs 2.65g of anhydrous Na_2CO_3 and put in to a separate container they also measured 250.00cm^3 of distilled water separately and were asked to determine the quantity required to dissolve in 1000cm^3 of water to give same concentration i.e If 2.65g ⟶ 250cm^3 ? ⟶ 1000cm^3 The students dissolved the salt in the distilled water and form a solution.	The students understand how to prepare solutions of require concentration The students understand how to do The students understand how to do some calculations and

	Na=23, C=12 and O=16. (23 X2) + (12 X1) + (16 X3)] = 106g/mol. If 1mol weigh ⟶ 106_g Na_2 0.4moles will weigh ⟶ Xg = 0.4mol X 106_g/mol = 0.4 X 106_g = 42.40g of Na_2CO_3 The teacher explains to the students that the mass of a substance is the quantity of the substance measured in grams which could be dissolve in certain volume of water to form a solution. While mole is the amount of a substance in a given solution.	The students participated on how to do some calculations, conversions and balancing of equations.	conversions and balancing of equations. .
Step IV Cont.	The volume of a liquid is the quantity usually measured in cm^3 or dm^3. The teacher further explains to the students how to do calculations from stoichiometric equations. (i.e mass-mole, mass-volume, mass-mass and mole-mole relationships) e.g (1) how many moles are present in 15.00_g of carbon atom? (C=12) **Solution:** Using Amount in mole =mass/molar mass, hence mass of carbon **M**=15.0_g & **mm** = 12.0g/mol ∴ **n = M/mm** =15.0g/12.0g/mole = 1.20moles. (2) Calculate the mass of Iron in 0.025moles of Iron fillings (Fe=56). **Solution**: if 1mol of Iron weigh 56g, ∴ 0.025moles will weigh Xg = 0.025mol X 56g 1mol = 1.40g of Iron. (3) what mass of calciumoxide will	The students participated on how to do calculations, from simple stoichiometric equations.	The students understand how to do calculations from equations.

	be obtain by heating 50.0_g calciumtrioxocarbonate(IV)? [C=12, Ca=40 & O=16]. **Solution:** First balance the equation for the reaction as follows $CaCO_3 \xrightarrow{\Delta} CaO + CO_2$ Then, calculate the molar mass of each compound respectively. {40+ 12+40+16 12+32 +(16X3)} $=56_g/mol$ $=44_g/mol$ $=100_g/mol$ If 100_g/mol yields 56_g of CaO, ∴ 50_g will produce X_g $= \frac{50X56}{100} = 28.0_g$		
Step IV cont.	Teacher explain to the students the relationship of those quantities in a stoichiometric equations e.g (i) consider the reaction $\mathbf{3H_{2(g)} + N_{2(g)} \longrightarrow 2NH_{3\,(g)}}$ a) How many moles of H_2 gas will react with 2.0moles of nitrogen gas? b) How many moles of nitrogen gas will produce 3.0moles of ammonia? c) how many moles of ammonia will be obtained from 4.5moles of hydrogen? Solution: **a)** To calculate the amount of H_2 molecules, given : 2.0moles of N_2. i.e mole-mole relationship between N_2 &H_2 from the equation of the reaction, $3H_2 + N_2 \longrightarrow 2NH_3$ 3moles 1moles 2moles If 1mol of N_2 requires 3moles of H_2, ∴ 2.0moles will require (2X3) = 6.0moles **b)** to calculate the amount of N_2 given 3.0 moles of NH_3(i.e mole-	Each student tries to solve the calculations from simple Stoichiometric equations individually Learners listen to the teachers' explanation. Appreciate the new concepts and copy on their note books.	The students understand how to solve some problems involving calculations from the equations. Students understand the concepts of volumetric analysis.

	mole relationship) from the equation of the reaction; 1mole of N_2 yields 2moles of NH_3 Xmoles of N_2 will yield 3.0moles of NH_3 $= 3 \times 1/2 = 3/2 = 1.50$moles of$N_2$	Students listens with interest and copy on their note book. -Learners listen to the teachers' explanation. Appreciate the new concepts and copy on their note books.	Students understand the purpose of Acid-bas titration.
STEP V Facilitation of the development of concepts	The teacher explains the concepts in volumetric analysis to the students such as -endpoint of reaction as a point at which the indicator changes its colour and this signals the approach of the equivalence point. Equivalence point is a situation where the titrant (acid) and titrand (base) are exactly in the same mole ratio. a neutralization reaction is the reaction between acid and base to produce salt and water only. The teacher further explains the purpose of acid-base titration as follows: -to standardized a solution of acid or base -to determine the relative molar mass of an Acid or base. -to establish the mole ratio of acid to base. -to determine the %purity of Acid or base -to estimate the % of water of crystallization in Acid or base. The teacher asks questions to evaluate the achievement of the	Learners listens to the teacher with interest and responds to the questions asked by the teacher and finally review and summarizes what they have done and learnt during the lesson.	Confirmation of the meaning of volumetric analysis and the concepts involved in titration.

STEP VI Evaluation/ conclusion	objectives e.g. explain the meaning of the following: -titration, endpoint, equivalent point, neutralization point. Teacher concludes the lesson by summarizing the important points.		

UNIT III

Name of the Teacher: Binta A. Mohammad
Reg N0. Ph.D/Educ/04868/2008-2009
Topic: Redox reactions
Class: SSII
Time: 1 hour

Concepts in the lesson

- Reductant
- Oxidant
- Oxidation
- Reduction
- Oxidizing agent
- Reducing agent

Instructional materials: $H_2SO_{4(aq)}$, $HNO_{3(aq)}$, $SO_{2(g)}$, $FeCl_{2\,(aq)}$,$KMnO_{4(aq)}$, $Mg_{(s)}$, $HCl_{(aq)}$,$H_2O_{(l)}$, burettes, pipettes, conical flasks, beakers, retort stands/clams, white tiles and dropping bottles.

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

- Explain redox reaction
- Define oxidation and reduction
- Explain the meaning of oxidizing and reducing agents
- Give examples of oxidizing and reducing agents.

Previous Knowledge: The students have learnt about volumetric analysis where by oxidation and reduction is taking place simultaneously.

Rationale: Oxidation – reduction reaction are those reaction in which oxidation and reduction occurs which involve the transfer of electrons from one atom to another. It is very important in the sense that there is electron transfer in almost every reaction.

LESSON DEVELOPMENT (60minutes)

Stages	Teachers' support	Learners' activity	Learning point
STEP I Full class Establishing a connection between the concepts to be learnt and the students existing knowledge	Teacher asks the learners what happens when an atom looses an electron and when it gains electron? and also Asks learners what they understand by the concept oxidation and reduction.	Reflects on what happen when an atom loses or gains electron. Responds to teacher's questions. The learners are familiar with balancing of redox reaction.	Develop ideas about gain and loose of electron. Develop the concept of oxidation and reduction
STEP II Improvement on the information of concepts	The teacher explains redox reaction as those reactions in which electrons are transferred from one atom to another. This is accompanied by a change in oxidation number of the species involved. A redox reaction can also be viewed as a reaction in which one substance is oxidized while the other is reduced. In redox titration no external indicator is required e.g. reaction involving $KMnO_4$ because it acts as an indicator. Teacher further explains oxidation to the students in terms of electron transfer <u>Oxidation</u> – is a process in which a substance loses electron leading to an increase in the oxidation number of the specie involved. $Fe^{2+} \rightarrow Fe^{3+} + e^-$ <u>Reduction</u> – is a process in which a substance gain electron leading to a decrease in the oxidation number of the species	Learners listen to teacher's explanation. Appreciates the new concepts and writes in their note books. Learners reflect on the concepts of oxidation and reduction involving the loose or gain of electrons.	Understanding the concept oxidation and reduction Develop idea of the objective of the lesson

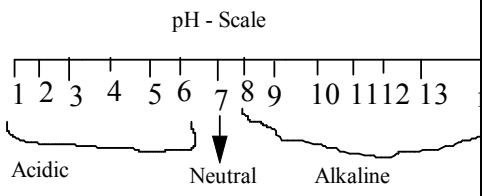
	involved $Fe^{3+} + e^{-} \rightarrow Fe^{2+}$ Oxidation and reduction reaction occur simultaneously as one substance looses electrons the other substance accepts the electrons.		
STEP III Facilitation of the development of concepts	Teacher explains the meaning of oxidizing and reducing agents to the students e.g. the substance that is reduced in a redox reaction is called the <u>oxidizing agent</u>. Common examples are H_2SO_4. Con. HNO_3, MnO_2 powder, $KMnO_4$ (purple) $K_2Cr_2O_7$ (yellow), hydrogen peroxide, Cl_2, Br_2, I_2 etc. while the substance that is oxidized in a redox reaction is called the reducing agent. It reduces the oxidation number of the other substances e.g. Sulphur (iv) oxide (SO_2), hydrogen sulphite H_2S among others	Students listens with interest and copy on their notebooks	Learners understand the meaning of the terms oxidizing agents and reducing agents.
STEP IV Evaluation/ Conclusion	Teacher asks questions to evaluate the achievement of the lesson such as - what is redox reaction - define oxidation and reduction - give E.g of oxidizing and reducing agent -	Learners summarize what they have learnt in the lesson.	Confirms the meaning of redox reaction.

UNIT IV

Name of the Teacher: Binta A Mohammad

Reg No.	Ph.D/Educ/04868/2008-2009
Topic:	pH Scale and Indicators
Class:	SSII
Time:	1 hour
Instructional materials:	Different basic and Acidic substances, litmus paper, methyl orange, phenolphthalein, methyl red.
Concept in the lesson:	i. Hydroxonium ions ii. Oxonium ions iii. Indicators iv. Equivalence point
Learning objectives:	By the end of the lesson students should be able to; - Explain the meaning of pH - State what indicators are - State the range of Acid and basic pH - State which 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.
Rationale:	Indicators are used in the laboratory during volumetric analysis different types of reactions have different indicators used while pH is used to measure the Acidity or alkalinity of a substance.

LESSON DEVELOPMENT (60 minutes)

Stage	Teacher's support	Learner's activity	Learning point
Step I introduction Full class	Teacher asks the students what they understand by pH scale and indicators. Teacher shows the students some basic and Acidic materials with indicators and litmus papers	Responds to teacher's questions Students watch with interest on the instructional materials	Develop ideas on the objective of the lesson
Step II Establishing a connection between the students existing knowledge and the concepts in pH scale and indicator	Teacher states that 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 form 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.  Teacher further explains indicators as weak organic Acids and bases that changes colour depending on $[H^+]$ hydrogen or $[H_3O^+]$ hydroxonium ion concentration	Students listens with interest and copy in their note books Students listens to teacher's explanation	Students understand the meaning of pH Students understand the meaning of indicators

<table>
<tr>
<td>Step III
Improvement in the formation of concepts</td>
<td>Teacher explains that 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 titrations to detect the endpoint of a reaction and to test the Acidity or alkalinity of a solution.</td>
<td>Students listens with interest
Students distinguish the different pH range for Acidic, neutral and basic substances.</td>
<td>Students understand the pH range for different solutions.</td>
</tr>
<tr>
<td>Step IV
Facilitates the development of concepts
Full class</td>
<td>Teacher asks learners to choose their leaders and secretary
Teacher then gave some groups Acids, others were given alkali and some groups were given a neural solution. The teacher then gave the students litmus papers and different indicator and draws the table on the board.</td>
<td>The students listens with interest and copy on their notebooks</td>
<td>Students understand what indicators are.</td>
</tr>
<tr>
<td>Step V
Facilitates the development of classification rule.
Group work</td>
<td>
<table>
<tr><td rowspan="2">Indicator</td><td colspan="3">Colour change in</td></tr>
<tr><td>Acid</td><td>Neutral</td><td>Alkali</td></tr>
<tr><td>Methyl orange</td><td>Pink</td><td>Orange</td><td>Yellow</td></tr>
<tr><td>Phenolphthalein</td><td>Colourless</td><td>Colourless</td><td>Pink</td></tr>
<tr><td>Litmus solution</td><td>Red</td><td>Purple</td><td>blue</td></tr>
</table>
</td>
<td></td>
<td></td>
</tr>
</table>

<table>
<tr><th>Stages</th><th>Teachers' support</th><th>Learners' activity</th><th>Learning point</th></tr>
<tr><td>Step VI
Development</td><td>Teacher further explains to the students the choice of indicators since the accuracy of titration depends on the use of correct indicator therefore; a wrong choice of indicator usually leads to a wrong endpoint.
<table><tr><td>Strong Acid
V
Strong base</td><td>HCl
V
NaOH</td><td>7.0</td><td>any suitable indicator e.g methyl orange or phenolphthale</td></tr><tr><td>Strong Acid
V
Weak base</td><td>H_2SO_4
V
Na_2CO_3</td><td>5-6</td><td>methyl orange</td></tr><tr><td>Weak Acid
V
Strong base</td><td>$H_2C_2O_4$
V
NaOH</td><td>8-9</td><td>phenolphthale</td></tr><tr><td>Weak Acid
V
Weak base</td><td>CH_3COOH
V
NH_4OH</td><td>Variable</td><td>No suitable indicator</td></tr></table></td><td>Student writes the choice of indicators in their notebook</td><td>Students understand the suitable indicator used in titration and the pH range.

.</td></tr>
<tr><td>Step VII
Evaluation/conclusion</td><td>Teacher asks questions to evaluate to evaluate the achievement of the objectives
- Explain the meaning of pH
- what are indicators
- state the ranges of Acid and basic Ph</td><td>Students review and summarize what they have done and learnt during the lesson,</td><td>Confirmation of the meaning of pH and indicators</td></tr>
</table>

UNIT V

Name of the teacher: Binta A. Mohammad
Reg N0: Ph.D/Educ/04868-08-09
Class: SSII
Topic: Solution and solubility

Concept in the lesson

- Molar Concentration
- Crystallization
- Super Saturation
- Solute
- Solvent
- Colloids

Instructional materials: Beaker, Distilled water, Chalk particles table salt and sand.

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

- State the meaning of solution
- Mention the different types of solution
- Explain the following concepts
  i. Solubility
  ii. Concentration
  iii. Super saturated solution
  iv. Saturated solution
- Give examples of
- Mass concentration and
- Molar concentration of a substance

Previous Knowledge: the students have knowledge that when a cube of sugar is put into water it dissolves but when sand is put in water, it does not dissolve.

Rationale: Knowledge of solution and solubility is very important in chemistry and in our daily lives since in most cases especially in qualitative analysis substances are given in the powdered or crystalline form the student have to dissolve it in the appropriate solvent to form a solution.

LESSON DEVELOPTMENT (1hr)

Stages	Teachers support	Learners' activity	Learning
STEP I Full Class Establishing a connection between the concepts to be learnt and the students existing knowledge	Asks learners questions about solution and solubility. Students have the knowledge that sugar dissolves in water.	Responds to teacher's question	Develop ideas of the objective of the lesson.
STEP II Improvement on the formation of concept	The teacher explains and writes the meaning of solubility as a means of comparing the extent to which different solute dissolve in a given solvent while a solution is a homogeneous mixture of two or more substances Solute + solvent = solution There are different types of solution which include aqueous solution, true solution, chemical solution, ionic solution and colloidal solution. The teacher explains that solution of an acid (e.g dilute HCl) react completely with a solution of a base (e.g NaOH) to form salt and water and shows to the students the equations for such reactions. $HCl_{(aq)}+NaOH_{(aq)} \longrightarrow NaCl_{(s)} +H_2O_{(l)}$ The teacher further explains how solute forms ions in solution	Students listen with interest and copy on their note books. Learners observe how solutions and ions are formed.	Students understand the concept of solution and solubility. Learners understands how ions are formed in solutions.
STEP III Group work Development	Teacher ask learners to choose their leaders and secretaries. Teacher gives various groups different solvents and solutes to dissolve in the solvent and asks	Learners choose their group leaders and secretaries	Sense of leadership

	them to record their observation. Teacher asks one group to dissolve 2.0g of a salt in to $250cm^3$ volumetric flask and also asks another group to dissolve 4.0g of same salt into $1000cm^3$ and then asks group members which solution is more concentrated? The teacher goes on to asks another group that; if 2.0g of same salt dissolves in $1dm^3$ of water, how many grams of the same salt will be required to dissolve in to $2.50dm^3$ for the concentration to be the same? Also teacher gave those groups of students water in different quantities and also gave them different quantities of sugar to dissolve in the water. While teacher explains to the students that concentration is analogous to the term "sweetness" of a solution e.g. the concentration of a solution which contains 10.0g of sugar per dm^3 of solution is more than the one that contains 2.0g of sugar per dm^3 of solution. The three variables that are used to describe solution in its context are i. concentration (c) ii. amount (n) iii. volume (v) mathematically concentration is inversely proportional to the volume of solution	Learners describe their experience and what they observed. Learners did exactly what the teacher asked them to do and observe what happens and they report their findings in their notebooks	Develop manipulative skills Learners understand the concept of concentration.
STEP IV Facilitates the development of concepts	Teacher further explains the following concepts to the learners a. solution – is a homogeneous	Students listens to teacher's	Develop ideas for the objective of the lesson.

	mixture of two or more substances. b. saturated solution- when a solution contains the maximum amount of the solute, it can dissolve in the presence of undissolved solute at a particular temperature. The solubility of a solute is expressed in moles per dm^3. On cooling a saturated solution excess solute will crystallize out. This is so because solubility of solutes generally decreases with decrease in temperature.	explanation and copy in their notebooks.	
STEP V Lesson Development	Teacher goes on to explain how concentration varies with volume and amount of substance dissolved in it for instance - concentration is inversely proportional to volume, if the amounts of substance remains constant C 1/V - Concentration is directly proportional to the amount (n) of the substance present, if the volume of the solution remains constant. Standard solution – a standard solution is a solution of known concentration. It is prepared by weighing a pure solute and dissolving in a suitable solvent and making the solution to a definite volume in a volumetric flask. The teacher also asks the students to take some quantity of solute substance, dissolve in $25cm^3$of distilled water by stirring the solution, and observe what happens until it can no longer	Learners listen to the teacher's explanation with interest and copy the notes in their books. Learners did what the teacher asks them to do they observed that the	Learners understand the concepts of saturation

	dissolve the solute. That means the solution is saturated.	solution become saturated.	
STEP VII Facilitation of classification rule	Teacher explains to the students the different solute and suitable solvent required to dissolve them. The teacher gives the students samples of some solutes substances such as common salt, sugar, benzoic acid, Iodine crystals, naphthalene, chalk particles and sand and solvents; such as distilled water, petrol, ethanol and benzene solution. And then, asks the students to dissolve the solutes in the appropriate solvent(s) and identify the solvent that dissolves the solute completely. **solute** **Solvent** common salt ----- Water ---- Water chalk particles ----- Water ---- Benzene sugar ---- Ethanol ---- ethanol, Iodine ---- &petrol Benzene &	Learners classify the different solute based on the solvents in which it dissolves.	
STEP VIII Evaluation/ conclusion.	Naphthalene --- Paint ------ The teacher asks learners the following questions to evaluate the lesson 1) what is a standard solution? 2) what is a saturated solution?	Learners revised what they have done and learnt during the lesson.	

	3) states the meaning of - mass concentration -molar concentration. The teacher finally concludes the lesson.		

UNIT VI

Name of teacher: Binta A. Muhammad
Registration number: Ph.D/Educ/04868/2008/2009
Topic: Separation techniques
Class: S.S.II
Instructional materials: Beaker, chalk articles, ethanol, oil, and common salt like sodium hydrogen trioxocarbonate.

Concepts in the lessons:

i. sublimation
ii. precipitation
iii. filtration
iv. Distillation
v. Decomposition
vi. Crystallization
vii. Mixture

Learning objective: By the end of the lesson students should be able to;

- Explain the meaning of mixtures
- Define what is meant by precipitation
- Explain some characteristics of mixtures
- State the various techniques used to separate mixture.

Rationale: separation techniques are very important in practical chemistry since some of the substances to be used in qualitative analysis are mixtures and the knowledge of separation technique can be applied.

Previous knowledge: The students are familiar with different mixtures in their homes and they are aware that oil and water are immiscible.

LESSON DEVELOPMENT (1hour)

Stage	Teacher's support	Learners activity	Learning point
STEP I Introduction Full class Establishing a connection between the concepts to be learnt and students existing knowledge	Asks learners what they understand by the term mixture and some of the techniques that can be used to separate mixture.	Learners responds to teachers question	Develop ideas for the objectives of the lesson.
STEP II Improvement on the formation of concepts	Teacher explains the concept mixture as the physical mixing of two or more constituents that can easily be separated by physical methods a mixture being a product of physical change exhibits certain characteristics such as; - constituents of a mixture are not chemically bounded together. - mixture cannot be represented by a chemical formula because the constitutions may be in any proportion by mass. - Each constituent in a mixture retains its identity.	Learners listen with interest and copy in their note books.	Learners understand mixtures and the characteristics of mixture,
STEP III Facilitates the development of concepts	Teacher further explains the meaning of filtration which is a method used to separate a mixture of solid in contact with a liquid in which it is soluble filtration is based on the difference in the physical state and the solubility of One component of the mixture in the other e.g. suspended particle in water. Distillation is a process in which a liquid is changed into	Learners listens with interest.	Learners understand filtration and distillation.

	vapour by heating and then the vapour is cooled, to obtain the liquid again.		
	Teacher explains that the method used to separate mixture depends on the type of mixture as well as its states	e.g. sample of sand in water	
STEP IV Facilitates the development of classification rule a) Filtration b) Sublimation c) Precipitation d) Distillation e) Fractional distillation f) Evaporation g) Crystallization h)Fractional crystallization	Teacher asks the students to choose their leaders and secretary Teacher gave different groups some substance to separate each group has given a different substance while the students will separate the mixtures.	crystals of Na_2CO_3 A solute containing led ions and Pb^{4+}, Calcium ions Ca^{2+} a mixture of $Pb(NO_3)_2$ Ethanol and water Fractions of petroleum Common salt and water. Sodium hydrogen trioxocarbonate (IV) and water. Or $NaHCO_3$ and Na_2CO_3 solution	
STEP V Group work	The teacher asks to evaluate the achievement of the objectives. - what is a mixture - what are the characteristics of mixtures - what is sublimation Give example of mixtures you can separate using distillation.	Learners did what teacher asks them to do. Each group did exactly what the teacher asks them to do and they recorded their results.	Learners used their skills to understand how to do the separation.
STEP VI Evaluation/ Conclusion		Learners review and summarize what they have learnt during the lesson.	Confirmation of the meaning of separating techniques.

APPENDIX 9:

Lesson plan for the Control Group
Unit I
Name of teacher: Binta A. Muhammad
Topic: Acids and Bases
Class: SS II
Time: 1hr
Instructional materials: Lemon, a sample of inorganic acid, litmus paper, beakers water. Potash, ash sodium hydroxide
Behavioural objectives: At the end of the lesson students should be able to:

a. Define Acids and bases
b. Mention some examples of Acids and bases
c. Mention some sources of naturally occurring Acids and bases
d. State the different types and strength of Acids and bases.

Introduction: The teacher introduces the lesson by asking the students to explain what they understand by the concept Acid and bases and further goes on to ask them for examples of Acids and bases.
Presentation:

Step I The teacher explain what an Acid is to the students as any substance which produces hydroxonium ion (or proton) as the only positive ion when dissolved in water.

$$HCl_{(s)} + H_2O_{(l)} \longrightarrow H_3O^+_{(aq)} + Cl^-_{(aq)}$$

An Acid according to Lewis is an electro pair acceptor but Bronsted – Lowry view an Acid as proton donor. While a base is any substance when dissolved in water they produce OH^- ions.

Step III: The teacher asks the students to squeeze the juice from the lime and to dissolve the ash and potash in water and to test the juice and the solution with both red and blue litmus paper and to record their observations.

Step IV: The teacher explains the two types of Acids and bases to the students:
Organic Acids and bases: occur naturally in plants and animals. Most of the fruits we eat contains Acids and the potash we use contains base e.g ethanoic Acid is present in vinegar while citric Acid is found in lemon and oranges.
(1)Inorganic Acids and bases are called the mineral Acids and bases because they are synthesized from mineral ores e.g HCl, HNO_3, NaOH, NH_4OH etc

Step V: The teacher explains to the students that Acids and bases classified as strong Acids and bases and weak Acids and bases.

(l) strong Acids and bases are completely ionized in water e.g H_2SO_4 HCl NaOH, KOH

(m) weak Acids and bases are organic Acids and bases that are only slightly ionized in water e.g CH_3COOH, H_2CO_3, NH_4OH,

Step VI: The teacher explains the properties of Acids and bases to the students e.g Acids have sour tastes and change blue litmus paper red react with more electropositive metals and release H_2 while bases are soapy to touch, turn red litmus paper blue and neutralizes Acids.

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

(1) what are Acids and bases
(2) what are the properties of Acids and bases
(3) give examples of Acids and bases.

Summary: the teacher concludes the lesson by highlighting the main points of the lesson and writes the chalkboard summary.

Control group Unit II

Name of Teacher: Binta A. Muhammad
Topic: Volumetric (titrimetric) analysis
Class: SS II
Time: 1 hr
Instructional Materials: Burette, pipette conical Flask, Volumetric Flask, beakers, Litmus paper

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

(1) Define Volumetric analysis
(2) Explain the meaning of titration
(3) State the meaning of
  (i) end-point
  (ii) equivalent point
(4)Explain Neutralization point of a reaction.

Introduction: The teacher introduces the lesson by asking the student what they understand by Volumetric analysis and the concepts involved in titration.

Presentation:

Step 1: The teacher describes the process of Volumetric analysis as a process which enables a scientist to determine the quantity of a substance present in a sample of materials. It involves measuring of the volumes of the reacting substances that are usually in the form of solutions weighing is involved, if the substance is a solid.

Step I1: The teacher goes on to show the students the process involved in titration and where the end point, equivalent point neutralization point is attained.

Step II1: The teacher explains the purpose of Acid-base titration as:

(1) to standardize a solution of an Acid or base
(2) to determine the relative molar mass of an Acid or base
(3) to establish the mole ratio of Acid to base
(4) to determine the percentage purity/impurity of an Acid or base.
(5) To estimate the percentage of water of crystallization in an Acid or a base.

Evaluation: The teacher evaluates the lesson by asking the following questions. Explain the meaning of titration and volumetric analysis (2) state the meaning of (1) end point equivalent point (3) Neutralization point.

Summary: The teacher concludes the lesson by highlighting the important points of the lesson and gives the chalkboard summary.

Control group Unit III

Name of teacher: Binta A. Muhammad
Topic: Redox Titration
Class: SS II
Time: 1 hr
Instructional Materials: H_2SO_4, HNO_3 beakers, Conical flask, H_2S, SO_2, Fe_2SO_4
Behavioural objectives – At the end of the lesson the students should be able to:

(1) Explain redox titration
(2) Define oxidation and reduction
(3) Explain the meaning of oxidizing and reducing agents.
(4) Give examples of oxidizing agents and reducing agents.

Introduction: The teacher introduces the lesson by asking the student the meaning of oxidation and reduction.

Presentation:

Step 1: The teacher explains the process of oxidation – reduction, titration to the students by describing the process.

Step I1: The teacher explains the reason why no external indicator is required for redox titration

Step III: The teacher explains the meaning of the oxidation, reduction, oxidation agents and reducing agents to the students.

Step IV: The teacher goes on to explain he meaning of oxidizing agents and reducing agents

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

(1) What is redox reaction
(2) Define oxidization and reduction
(3) Explain the meaning of oxidizing agents and reducing agents.
(4) Give examples of oxidizing agents and reducing agents.

Summary : The teacher concludes the lesson by highlighting the important points and giving the chalkboard summary.

Control group Unit IV

Name of the Teacher: Binta A. Muhammad
Topic: Solution and Solubility
Class: SS II
Time: 1 hr
Instructional Materials: Beakers, distilled water, chalk particles, table salt
Behavioural objectives – At the end of the lesson the students should be able to:

(1) State the meaning of solution
(2) Mention the different types of solution
(3) Explain the meaning of oxidizing and reducing agents.
(a) Solubility
(b) Concentration
(c) Super saturated solution.
(4) Give examples of oxidizing agents and reducing agents.
(a) mass concentration
(b) molar concentration

Introduction: The teacher introduces the lesson by asking the student what key understand by solution and solubility.

Presentation:

Step 1: The teacher describes the process of solubility to the students and the various types of solution.

Step I1: The teacher explains different types of solute and the suitable solvent required to dissolve the solute.

Step III: The teacher explains molarity and how to prepare a standard solution.

Evaluation: The teacher asks the students the following questions:

i. What is a standard solution
ii. What is a saturated solution
iii. Define the concepts solution and solubility.
iv. State the meaning of the following concepts.

Summary: The teacher concludes the lesson by highlighting the main points of the lesson.

Control group Unit V

Name of the Teacher: Binta A. Muhammad
Topic: pH scale and indicators
Class: S.S. II
Time: 1hr
Instructional materials: Different basic and Acidic substances, pH meter Litmus paper, Methyl Orange Phenolphthalein, Methyl red

Behavioural objectives: At 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 which indicators are better for teacher introduces

Introduction: The teacher introduces the lesson by asking the students that they understand by pH scale and indicators.

Presentation

Step I: The teacher explains to the students the pH of a solution or liquid as a measure of the amount of hydrogen ion concentration ($H^{+)}$ or hydroxonium ion (H_3O^+) present in a solution. Generally the pH scale extends from 0 to 14. pH 7 = neutral, pH O to less than 7 = Acidic pH 7 and above = Alkaline.

Step II: The teacher for then explains that indicators used is Acid base titration to detect the end-point of a reaction in Acid-base titrations.

Step III: The teacher explains the colour of indicators commonly used the pH range where the colour change takes place and the pK range using a table.

Step IV: The teacher explains the choice of indicators, since the accuracy of titration depends on the use of the correct indicator, because a wrong choice of indicator usually leads to a wrong end-point.

Step V: The teacher explains the pH titration curves, when a solution of a base e.g $NaOH_{(aq)}$ gradually added into a solution of an Acid, e.g HCl(aq).There is a general increase the pH of the mixture however, the overall shapes the pH curve depends on the strength of the Acid and base involved in the reaction.

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

(1) Explains the meaning of pH
(2) What are indicators?
(3) State the ranges of Acid and basic pH.

Summary: The teacher concludes the lesson by highlighting the main points of the lesson.

Control Group Unit VI

Name of teacher:	Binta A. Muhammad
Topic:	Separation techniques
Class:	SS II
Time:	1hr
Instructional materials:	Beaker, water chalk particles ethanol, oil, common salts like sodium hydrogen trioxocarbonate (iv)

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

(1) Explain the meaning of mixtures.
(2) State the various technique used to separate mixtures
(3) Explain some of the characteristics of mixture.

Introduction: The teacher introduces the lesson by asking the students what key understand by the term mixture and the various techniques that can be used to separate.

Presentation:

Step 1: The teacher explains the various technique techniques used for the separation of mixtures by showing them physically.

Step I1: The teacher explains some of characteristics of mixtures to the students.

Evaluation: the teacher evaluates the lesson by asking the following questions.

Summary: The teacher concludes the lesson by highlighting the important points of the lesson.

APPENDIX 10:

ANALYSIS OF POSTTEST MEAN SCORES

APPENDIX 11:

COMMUNICATIONS ON THIS STUDY