

**INFLUENCE OF KNOWLEDGE OF BEHAVIOURAL
OBJECTIVES ON PERFORMANCE AND RETENTION IN
ORGANIC CHEMISTRY AMONG SECONDARY SCHOOL
STUDENTS IN KADUNA NIGERIA**

BY

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OCTOBER, 2021

DECLARATION

I hereby declare that this dissertation titled **Influence of Knowledge of Behavioural Objectives on Academic Performance and Retention of Secondary School Chemistry Students in Giwa Education Zone, Kaduna Nigeria** has been written by me. It is a record of my own research work and it has not been presented in any previous dissertation for a higher degree. All quotations and sources of information are fully acknowledged by means of references.

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CERTIFICATION

This dissertation titled **Influence of Knowledge of Behavioural Objectives on Academic Performance and Retention of Secondary School Chemistry Students in Giwa Education Zone, Kaduna Nigeria** by Samuel Oluwagbemiga AKINLOYE with registration number P16EDSC8037 meets the regulations governing the award of Masters degree in Science Education, Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and library presentation.

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DEDICATION

This research work is dedicated to my parents Elder Thomas Oluwafemi Akinloye and Deaconess Florence Akinloye.

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TABLE OF CONTENTS

Title	Page
Declaration	ii
Certification	iii
Dedication	iv
Acknowledgement	v
Table of Contents	vi
List of Tables	x
List of Figures	xi
List of Appendices	xii
List of Abbreviations	xiii
Operational Definition of Terms	xiv
Abstract	xv
CHAPTER ONE: THE PROBLEM	
1.1 Introduction	1
1.1.1 Theoretical Framework	6
1.2 Statement of the Problem	7

1.3	Objectives of the Study	9
1.4	Research Questions	10
1.5	Null Hypotheses	10
1.6	Significance of the Study	11
1.7	Scope of the Study	12
1.8	Basic Assumptions	13
CHAPTER TWO: REVIEW OF LITERATURE		
2.1	Introduction	14
2.2	Historical Perspective of Science Education	15
2.2.1	Philosophy and Objectives of Science Education in Nigeria	18
2.3	Teaching of Chemistry	21
2.3.1	The Senior Secondary School Chemistry Curriculum	26
2.4	Students' Academic Performance in Chemistry at Senior Secondary Schools	27
2.4.1	Retention of Learnt Materials and Academic Performance in Chemistry	29
2.5	Concept of Hydrocarbons	30
2.6	Concept of Behavioural Objectives in Science Teaching	32
2.7	Overview of Similar Studies	36
2.8	Implications of the Literature Reviewed for the Present Study	48

CHAPTER THREE: METHODOLOGY

3.1	Introduction	50
3.2	Research Design	51
3.3	Population of the Study	52
3.4	Sample and Sampling Technique	54
3.5	Instrumentation	55
3.5.1	Concept selected for the Study	55
3.5.2	Instrument Used for Data Collection	56
3.5.3	Validity of the Instrument	58
3.6	Pilot Testing	59
3.6.1	Reliability Coefficient of the Instrument	60
3.6.2	Determination of Item Characteristics	61
3.7	Administration of Instrument	63
3.8	Procedure for Data Collection	64
3.9	Procedure for Data Analysis	64

CHAPTER FOUR: ANALYSIS, RESULT AND DISCUSSION

4.1	Introduction	66
4.2	Presentation of the Results and Data Analysis	66
4.2.1	Answers to Research Questions and Testing Null Hypotheses	66

4.3	Summary of Findings	74
4.4	Discussion of the Findings	74
CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS		
5.1	Introduction	77
5.2	Summary of the Study	77
5.3	Summary of Major Findings	79
5.4	Conclusion	80
5.5	Contributions to Knowledge	81
5.6	Recommendations	81
5.7	Limitations of the Study	82
5.8	Suggestions for Further Studies	82
REFERENCES		83
APPENDIX		94

LIST OF TABLES

Table	Page
1.1 Students' WAEC Result in Chemistry	8
3.1 Population of the Study	53
3.2 Sample Size for the Study	55
3.3 Item Specification for the Hydrocarbon Concepts Performance Test	58
4.1 Mean and Standard Deviation Statistics of Pretest and Posttest HCPT Scores for Students in Experimental Group	67
4.2 Summary of t-test Analysis of Pretest and Posttest Mean Academic Performance Scores of Experimental Group	68
4.3 Mean and Standard Deviation Statistics of Pretest and Posttest HCPT Scores for Male and Female Students in Experimental Group	69
4.4 Summary of t-test Analysis of Pretest and Posttest Mean Academic Performance Scores of Male and Female Students in Experimental Group	70
4.5 Mean and Standard Deviation Statistics of Pretest and Posttest HCPT scores for Students in Experimental and Control Group	70
4.6 Summary of t-test Analysis of Academic Performance Mean Scores of	

Experimental and Control Groups	71
4.7 Descriptive Statistics of Experimental and Control Group Retention Level	72
4.8 Summary of t-test Analysis of Retention Level Mean Scores of Experimental and Control Group	73

LIST OF FIGURES

Figure	Page
3.1 Research Design	51

LIST OF APPENDICES

Appendix		Page
A	Hydrocarbon Concepts Performance Test	94
B	Marking Scheme for Hydrocarbon Concepts Performance Test	103
C	Hydrocarbon Concepts Performance Test (HCPT) Answer Sheet	104
D	Lesson Plan for the Experimental Group	105
E	Lesson Plan for the Control Group	120
F	Item Analysis for Hydrocarbon Concept Performance Test	132
G	Frequencies of Experimental and Control group Academic Performance	133
H	t-test Statistics of Experimental and Control group Academic Performance	134
I	t-test Statistics of Experimental and Control group Retention Level	135
J	t-test Statistics of Pretest & Posttest mean scores of Experiment Group	136

LIST OF ABBREVIATIONS

The following provides the list of abbreviations used in the study and their full meanings.

HCPT	Hydrocarbon Concepts Performance Test
STAN	Science Teachers Association of Nigeria
GSS	Government secondary school
GGSS	Government girl's secondary school.
PPMC	Pearson Product-Moment Coefficient
SPSS	Statistical Package for Social Science
SSCE	Senior School Certificate Examination
WAEC	West African Examination Council

OPERATIONAL DEFINITION OF TERMS

The following provides the operational definition of terms and variables used in the study.

Science: It is an embodiment of knowledge or subject which includes Physics, Chemistry, and Biology at senior secondary school and tertiary institutions.

Chemistry: It is a science subject that is concerned with the study of matter, its structure, composition, properties and changes they (matter) undergo.

Behavioural Objectives: Are statements of proposed changes expected from learners after they have been exposed to learning for a specified period of time.

Academic Performance: They are scores that students obtained after a test or examination at the end of a program or instruction.

Retention: It is the ability to store information for a period of time after a given instruction.

Hydrocarbon: Are organic compounds composing of only carbon and hydrogen atoms in their molecules.

ABSTRACT

This study investigated the influence of knowledge of behavioural objectives on academic performance and retention in organic chemistry among secondary school students in Kaduna Nigeria. The study adopts a Quasi-Experimental Pretest-Posttest control group design, Non-equivalent Groups. The population comprised all 667 Chemistry students from 14 public Senior Secondary Schools in Giwa Education Zone. A sample of 133 students from two randomly selected co-educational schools was used for the study. The study involves two groups. The experimental group was taught Hydrocarbon concept with knowledge of behavioural objectives while the Control Group was exposed to same concept using Conventional Method. Hydrocarbon Concept Performance Test (HCPT) with have reliability coefficient of 0.83 estimated using Pearson Product Moment Correlation (PPMC) static was used to collect data. Four research question and four null hypotheses guided this study. Research questions were answered using Mean and Standard Deviation statistics while null hypotheses were tested using Independent samples t-test at 0.05 level of significance. The results of the finding revealed that there is a statistically significant difference between the mean performance scores of chemistry students exposed to knowledge of behavioural objectives and those not so exposed in favour of the experimental group. Based on the findings of this study it was recommended among others that science teachers should be encouraged to apply knowledge of behavioural objectives in their teaching-learning process.

CHAPTER ONE

THE PROBLEM

1.1 Introduction

Science education plays prominent roles in determining scientific and technological advancement of individuals and nations. Nwagbo & Ovute (2011) posited that for any nation to experience economic development there must be strong and stimulating growth in the teaching and learning of science. The classification of nations into developed, developing and under-developed is therefore based on their Technological Advancement (Agogo 2009, Maduawesi, Aboho and Okwuedei, 2010). This may be the reason why Achor (2006) and Ada (2008) opined that as a result of the speed at which the world is changing technologically, the need and usefulness of teaching and learning of science should not be over looked.

Chemistry is one of the core science subjects taught in Senior Secondary Schools in Nigeria. It is also recognized as one of the basic subjects for scientific and technological development. Ojokuku (2010) defined Chemistry as a branch of science which deals with the study of matter, its structure, composition, properties and the changes they (matter) undergo. The importance of Chemistry as a basic requirement for economic, scientific and technological development of any nation cannot be over emphasized. There have been researches such as Eke (2008), accepting that any Nation aspiring to be scientifically and technologically developed must have adequate level of chemistry education. However, Umahaba (2016) observed that a solid foundation cannot be laid unless more secondary school students choose to offer chemistry and also perform impressively in both school-based and national examinations. Chemistry cannot be isolated from everyday living since human beings have always been in contact with and use chemical products such as cosmetics, drugs, detergents, soaps, fertilizers, insecticides, the technology of which require the basic knowledge and application of chemistry. The assertion that chemistry is the

bridge of science according to (Umahaba, 2016) is based on the pivotal role which chemistry plays in industrial establishments and also in other professional disciplines such as Engineering, Agriculture, and Medicine. These are basic necessities for the improvement of quality of the life of the citizenry.

Based on the relevance of chemistry as highlighted, it is expected that the study of chemistry and students' performances in public examinations would be qualitative and impressive. However, the performance of Nigerian secondary school students in the subject has for many years remained poor and thus has become a matter of serious national concern (Jegede, 2010, Oloyede, 2010). Many factors have been suggested as contributing factor to this poor performance of students in chemistry in particular and science in general. Some of these factors include: the abstract nature of chemistry concepts (Samba and Eriba, 2012); students and teachers related factors (Maduwo, Agogo and Kpagh, 2009); concept difficulty (Agwai, 2008) among others. According to Ayeni (2011), teaching is a process that involves bringing about desirable changes in learners. School programmes and other pedagogical functions are guided by purposeful and expected outcomes such as positive skills as well as acquisition of functional knowledge. Nzewi (1990) opined that the way material is introduced has a great deal to do with students' motivation and learning; carefully designed introductory activities can do a great deal to bridge a gap between what is known and what the students need to know. Ogenewede (2012) observed that, for effective teaching to take place, the teacher must stimulate, encourage and maintain active participation of students through the selection of appropriate teaching methods. He stressed that successful teaching does not depend only on the teachers mastery of the subject matter, but also the teaching method employed.

Educators have for long time been interested in pedagogical techniques and ideas about how best human beings learn. Educators outlined some steps for successful learning that teachers should follow if students are to learn effectively, (Khadar, 2010). One of these pedagogical techniques is by setting the learning objectives before the commencement of instruction. These objectives may be written in various forms which includes as aims of the lessons; as goal of the lessons; and as objectives of the lessons.

Aims tend to be more general than goals and objectives, because the latter terms relate to more specific tasks, while aims according to Marsh (2007) are broad outcomes which are achievable in the long run. Aims are relatively vague, and are usually achieved after a long time. Goals are clearer statements of intent and are more specific than aims. A goal is a broad statement that describes what the learner will gain from instruction, while objectives are the steps needed to achieve a goal, (Marzona & Kendall, 2007). Objectives are the activities planned out to bring aims and goals to fruition. Objectives are usually stated in a more concrete, specific and measurable terms. Therefore, clearly defined objectives form the learning activities and assessment measures. Such objectives are generally referred to as behavioural objectives.

Behavioural objectives are performance-oriented, beginning with an action verb, written in the future tense and typically specifying the desired level of performance (Smaldino, 2007). Amadi (2006) defined behavioural objectives as statements of proposed changes expected from learners after they have been exposed to learning for a specified period of time. These changes, desired and valued by the teacher are expected to occur in thought, actions and feelings of the students. A learning objective answers such question as: what is it that the students are expected to do at the end of the lesson that they could not do before? They (behavioural objectives) usually form the starting point of a lesson plan for effective teaching. Yusuf (2012) observed that statement of learning objectives performs the functions of guiding the teacher relative to the design of

instruction, and for evaluation. According to Schunk (2011) specific and clear objectives are more likely to enhance students' academic performance as they can be used to guide students as they work through the course and to assess their learning process. Excellent behavioural objectives provide a guide for students when reviewing materials and preparing for assessments. Behavioural objectives are the most powerful if they are actionable and measurable. It is therefore the prospect of this study to find out if knowledge of behavioural objectives would improve the academic performance scores of secondary school chemistry students.

Academic performance is defined as the extent to which learners performed in the lesson taught or in examination result (Mari, 1994). Researchers, for example, (Abulkarim & Lawal 2012; Lakpini & Atadoga, 2013) worked on teaching method and academic performance in science education. The overwhelming views of these researchers indicated that there is a relationship between the type of instructional method adopted in teaching and students' academic performance as the quality of the instructional method adopted is often reflected by the performance of learners.

Retention goes hand-in-hand with academic performances. It is defined as the ability to retain things or experiences previously learned. Several factors are known to influence retention of learned materials. Lakpini (2006) defined retention as the ability of the memory to store information which can be recalled after interval of weeks when exposed to a series of instructions. Studies carried out by Lakpini (2006) and Anaso (2008) revealed that students exposed to conceptual change instructional strategy such as knowledge of behavioural objectives retained scientific concepts better than those taught using lecture method. This is because knowledge of behavioural objectives makes better understanding of chemistry concept and deeper understanding of the concept, and it also leads to better academic performance and

retention. It is therefore the aim of this study to find out if students exposed to knowledge of behavioural objectives before instruction will have better retention than those not exposed.

In this study therefore, knowledge of behavioural objectives are seen as advanced organizer in teaching approaches and it involves giving the students a well-stated behavioural objectives by the teacher before the commencement of the lesson. Mbakwem (2009) reported that knowledge of behavioural objectives provides students with a means to organize their own efforts towards the accomplishment of the objectives. Similarly, Uche and Uromen (2007) opined that knowledge of behavioural objectives enables students to focus their energies and have more accurate idea of what is expected of them to achieve at the end of the lesson. The need thus arises to find out if the academic performance score of secondary school chemistry students would improve if they have knowledge of behavioural objectives of their lessons. This constitutes the centre-piece of this study.

Bichi (2002) defines gender as the amount of masculinity or femininity in an individual. Ajayi & Osoko (2013) observed that studies on the effects of gender on students' academic performance have so far been inconclusive. Researches on gender and academic performance such as those of Ibrahim (2012) and Umar (2013) reveal that boys achieved academically better than girls. On the contrary, studies by Bunkure (2012) and Dahiru (2013) point out that girls achieved academically better than boys. However, a number of other studies like Ibrahim (2015) and Umahaba (2016) reveal no significant difference in the academic performance of male and female subjects. Therefore, this study among other things is set to find out if there are significant differences between male and female secondary school Chemistry students in their academic performance when exposed to knowledge of behavioural objectives of lesson before instruction.

1.1.1 Theoretical Framework

A number of science education researchers like Lawal (2009), Akezuilo and Chinweoke (2009), and Igbojinwaekwu (2012) have been concerned with developing ways of facilitating students' conceptual development. This research stressed the influence of knowledge of behavioural objectives on academic performance and retention. This is in line with Ausubel's (1963) assertion that the most important factor influencing learning is what the learner already knows.

Knowledge of behavioural objectives is based on Advance Organizer theory of Ausubel (1963). **Ausubel (1963) proposed a learning theory which he called the Subsumption theory. According to Ausubel's subsumption theory, a student absorbs new information by tying it to existing relevant concepts and ideas that they have already acquired. Rather than building an entirely new cognitive structure, students are able to relate new knowledge to information that is already present within their minds. When an idea is forgotten, it is simply because the specific details and associated thoughts got lost in the crowd of ideas and can no longer be differentiated from other pieces of information.** When information is subsumed into students' cognitive structure, it is organized hierarchically. **Based on this theory, meaningful learning can only occur if cognitive structures have been well developed** (Pappas, 2015). **Ausubel's subsumption theory implies that** meaningful learning can only occur when what is to be learnt is related to what is already known which already exists in the students' mind. In other words, for a stimulus or concept to have meaning, there must be something related in the students' prior experience (**Shankar, 2010**). Hence, students can only learn more effectively if the new knowledge to be acquired is tied to their already existing knowledge base. In this theory, [Ausubel](#) stressed the need for utilization of advance organizers that connect previously established information to newly established information in cases where relevant knowledge is not present in the cognitive structure. [Advance organizers](#) operate as

bridges for information that stimulates prior information already stored in the learner's cognitive structure or schemas (Datar, 2013; Kumagai, 2013).

Based on the foregoing therefore, the present study attempts to find out the effect (if any) of knowledge of behavioural objectives on academic performance and retention of Secondary School Chemistry students' in Giwa Education Zone, Kaduna State, Nigeria.

1.2 Statement of the problem

This study is prompted by the observed consistent poor performance of Secondary School students in chemistry as revealed in their final examination in the West African Examinations Council over time. For example, the West African Examination Council (WAEC) Chief Examiners' report from 2010 to 2020 reveal among other things, that students' poor performance in chemistry examination are relatively poor when the percentage failure is compared against the passes at credit level. Table1.1 shows WAEC results of students in Giwa educational zone, Kaduna state from 2010-2020.

Table 1.1: The Performance of Students in Chemistry from 2010-2020

Year	Number of candidate that sat for WAEC	Number of students that passed (A1-C6)	Number of students (fail)	% of students that pass (A₁-C₆)	% of students that fail (D7-F9)
2010	182659	39125	143534	21.41	78.58
2011	228953	80355	148598	35.09	64.90
2012	250099	85150	163949	34.04	65.55
2013	289520	84520	205000	29.19	70.80
2014	326541	98215	228326	30.07	69.92
2015	367562	120560	247002	32.79	67.20
2016	428034	80233	347801	18.74	81.25
2017	659132	204330	454802	30.99	69.00
2018	866616	251319	615297	29.00	70.99
2019	791227	245280	545947	30.99	69.00
2020	758849	295951	462898	39.99	61.00

(Source: Research Division, West African examination council (WAEC) Kaduna State 2020).

Statistics in Table 1.1 indicate that despite the increasing number of candidates that registered for WAEC exams over the years under review, the percentage of the candidates with pass grades (A1-C6) is consistently below 45%. This shows empirically that students have been performing quite poorly in the examination every year. A number of literatures have noted the consistent poor academic performance of secondary school students in SSCE Chemistry (Ibrahim, 2015; Adegboye, Ganiyu & Isaac, 2017). This poor academic performance has been attributed mainly to improper use of instructional materials, large class size and the predominant use of lecture method in teaching chemistry concepts (Brimoh, 2008). The downward trend in the academic performance of students at SSCE can be noticed in Table 1.1 which presents a summary of the results in Chemistry from 2010 to 2020. In addition, from the analysis of the WAEC Chief

Examiners' Reports in Chemistry from 2010 to 2020, a recurrent manifestation of poor performance have been noticed by the researcher in chemistry concepts such as Redox Reactions, Mass-Volume relationship, Electrolysis and Hydrocarbon among others. Researches abound on the remediation of difficulties associated with Chemistry concepts such as Redox Reactions like Achor (2016), Mass-Volume relationship like Adebayo (2012) and Electrolysis like Afolabi & Adesope (2015) among secondary school students. However, studies geared towards improving secondary school students' academic performance in Hydrocarbons are limited. Therefore, this study seeks to address this problem by examining whether knowledge of behavioural objectives will enhance the academic performance in Hydrocarbon among secondary school Chemistry students in Giwa Education Zone, Kaduna State, Nigeria.

1.3 Objectives of the Study

The objectives of this study are to determine:

1. Pretest and Posttest mean performance scores of chemistry students exposed to knowledge of behavioural objectives.
2. if there are differences in the mean academic performance scores of male and female chemistry students exposed to knowledge of behavioural objectives of lesson.
3. the relative academic performance scores of chemistry students exposed to knowledge of behavioural objectives before instruction and those that were not exposed.
4. the retention level of chemistry students exposed to knowledge of behavioural objectives before instruction and those that were not exposed.

1.4 Research Questions

The study seeks to find answers to the following research questions.

1. What is the difference in the Pretest and Posttest mean performance scores of chemistry students exposed to knowledge of behavioural objectives?
2. What is the difference between the mean academic performance scores of male and female chemistry students exposed to knowledge of behavioural objectives of lesson?
3. What is the difference between the mean academic performance scores of chemistry students exposed to knowledge of behavioural objectives before instruction and those not so exposed?
4. What is the difference between the mean retention scores of chemistry students exposed to knowledge of behavioural objectives before instruction and those not so exposed?

1.5 Null Hypotheses

The following null hypotheses are formulated to guide the study procedure

HO₁: There is no significant difference between the Pretest and Posttest mean performance scores of chemistry students exposed to knowledge of behavioural objectives.

HO₂: There is no significant difference between the mean academic performance scores of male and female chemistry students exposed to knowledge of behavioural objectives of lesson.

HO₃: There is no significant difference between the mean academic performance scores of chemistry students exposed to knowledge of behavioural objectives before instruction and those not so exposed.

HO₄: There is no significant difference between the mean retention scores of chemistry students exposed to knowledge of behavioural objectives before instruction and those not so exposed.

1.6 Significance of the Study

The findings from this study are expected to be of benefit to many groups of people. These include the following:

Students: - The findings from the study may enable students to focus their energies and have more accurate idea of what is expected of them to achieve at the end of each classroom lesson once they get to know about the role of knowledge of behavioural objectives.

Teachers: - It is hoped that the findings may help chemistry teachers to identify one of the ways in which effective classroom learning can be achieved more effectively and economically. This technique may, therefore, serve as an additional guideline to science teachers in their quest to maximize effectiveness of learning outcomes.

Heads of Department: - The outcome of this study may, to some extent, help Head teachers and the Heads of department in encouraging science teachers to seriously consider the efficacy of providing students with behavioral objectives prior to instructions.

Curriculum planners: - The findings from this study may hopefully provide them with insight into the efficacy of behavioral objectives in instruction and thus in improving their skills in curriculum planning.

Researchers: - The findings from the study may help to benefit researchers since it may provide empirical evidence and contribute to the existing literature that is already available on the methods of teaching science in the schools as well as prepare ground for interested researchers who may wish to conduct further research in related areas.

Professional Bodies: The outcome of this study may help Science-based professional organizations like Science Teachers Association of Nigeria (STAN), Mathematics Association of Nigeria (MAN), National Educational Research and Development Council (NERDC) in giving needed emphasis in the scheme of academic guidance to further improve performance of their mandate.

1.7 Scope of the Study

This study investigates the influence of knowledge of behavioural objectives on academic performance and retention of secondary school chemistry students in Giwa educational zone, Kaduna state. It is delimited to public Senior Secondary 2 (SS2) Chemistry students in Giwa Education Zone, Kaduna State, Nigeria. The schools are owned by the state Government and the Ministry of Education supervises teaching and learning activities in them. SS2 students are used for this study and are considered suitable because they are stable and experienced in basic Chemistry concepts from their previous class (SS1), unlike SS1 students who are neither experienced in Chemistry nor fully settled for the study or SS3 students who are faced with their final year examinations. The concept to be taught in Organic Chemistry for the purpose of generating data is Hydrocarbon. In addition, hydrocarbon is chosen for this study because the concepts therein have been perceived and shown to be difficult for students to understand and to pass during examinations Obiaku (2016) and WAEC, 2010-2020). The topics chosen under Hydrocarbon are:

Hydrocarbon, Functional group, Alkane, Alkenes, Alkynes.

1.8 Basic Assumptions

The following Assumptions are made in this study:

1. Chemistry students at Senior Secondary School are not being exposed to the knowledge of behavioural objectives prior the commencement of lessons.
2. The Chemistry teachers in the schools use the same syllabus, Chemistry curriculum, scheme of work and recommended textbooks.
3. The Chemistry teachers in the schools are qualified and as such teach Chemistry effectively.
4. It is possible to determine the effect of knowledge of behavioural objectives on academic performance of chemistry students.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This study seeks to investigate the Influence of knowledge of behavioural objectives on academic performance and retention of Secondary School Chemistry students in Giwa Education Zone, Kaduna State, Nigeria. In this chapter, relevant literature on the study is reviewed and is presented under the following sub-headings:

2.2 Historical Perspective of Science Education in Nigeria.

2.2.1 Philosophy and Objectives of Science Education in Nigeria.

2.3 Teaching Chemistry at Senior Secondary School Level.

2.3.1 The Senior Secondary School Chemistry Curriculum.

2.4 Students' Academic Performance in Chemistry at Senior Secondary Schools.

2.4.1 Retention of Learnt Concepts and Academic Performance in Chemistry.

2.5 Concept of Hydrocarbons.

2.6 Concept of Behavioural Objectives in Science Teaching.

2.7 Overview of Similar Studies.

2.8 Implications of the Literature Reviewed for the Present Study.

2.2 Historical Perspective of Science Education in Nigeria.

The origin of science and science education according to Omiko (2015) and Ibrahim (2015) could be as old as the human race itself, arising from the need of man to solve various problems that threatened his survival as well as his desire to transmit the knowledge, ideals, values and norms acquired thereof to the younger generation. Abdullahi in Ogunmade (2005) noted that before the advent of Western education in Nigeria, certain aspects of scientific knowledge were included in traditional forms of education. The arrival of the British missionaries on the coast of Lagos in 1859 and subsequent establishment of churches and elementary schools in the town of Topo near Badagry in 1861 marked the beginning of western education in Nigeria. According to Martins Library BlogSpot (MLB) (2013), with the establishment of Church Missionary Society (CMS) Grammar School in Lagos in 1859, Roman Catholic Missionary (RCM), Wesleyan Methodist Mission (WMM), African Mission of South Baptist Convention, United Presbyterian Mission of Scotland Mission, the Qua Ibo Mission, some rudiments of science education were injected into the schools' curriculum including arithmetic, algebra, and geometry. Missionaries also established other schools namely, Grammar Teacher Training, pastoral, vocational and agricultural schools and the introduction of rudiments of science in school curricula and teaching of them. The curriculum consist of the 4Rs namely, Reading, writing, arithmetic and religion. The Hope Waddell Institute in Calabar founded in 1861, St. Andrews College, Oyo in 1876, Wesleyan Training Institute of 1905, Baptist Training Centre, Ogbomoso in 1899, etc. had science subjects in their curricula.

Up to 1932, there was no post-secondary institution for the learning in science after the only specialized institution, the medical school attached to the CMS Theological Institute founded in Abeokuta in 1961, folded up. The teaching of science however gained a stronger footing in about

1920 because of the recommendation of an African Education Commission which toured the British West African colonies under the sponsorship of the Phelps Stokes Fund of America (MLB, 2013).

In the account of Omolewa in Jimoh, Maigamo and Abari (2010), Science was first introduced as Nature Study in Nigeria by British Missionaries with the establishment of the Church Missionary Society (CMS) Grammar School, Lagos in 1859. This rudiment of science involved the teacher and his pupils learning about the environment in a form of outdoor observation of plants, animals and non-living things. However, Bajah in Usman, Ahmed and Tijjani (2014) added that by 1920, the zeal for Nature Study began to decline and it was no longer consistent with the psychology, philosophy and methodology of Education at the time. Nature Study was no longer adequate for the social and economic realities of the period thus promoting a change in the science aspect of the curriculum. The change was felt in Nigeria with the introduction of General Science in the secondary schools. Okeke in Jimoh, Maigamo and Abari (2010) noted that the three main branches of science – Biology, Chemistry and Physics - were introduced later for the last three years of secondary education in the 1950s.

Furthermore, according to Ojimba (2013) science education had undergone several curricular reforms to denote the science development efforts which were sparked off during the 1960s and 1970s by the sudden launching into space of the satellite “Sputnik” by the defunct Soviet Union in 1957. This development aroused the curiosity and subsequent questioning of the mode of science teaching and learning and the nature of the science curriculum existing in the United States of America and other nations of the world. Subsequently, a metamorphosis of several new science curricula emerged. These included the Physical Science Study (PSCS), Chemical

Educational Materials Study (CHEM study), Biological Science Curriculum Study (BSCS), all in the United States and the Nuffield Science Projects in the United Kingdom.

According to MLB (2013), the Nigerian nation became a part of these curriculum development efforts with the birth of Basic Science for Nigerian Secondary Schools (BSNSS) undertaken by the Comparative Education Study and Adaptation Centre (CESAC). The historic National Curriculum Conference that held from 8th to 12th September, 1969 further spurred various bodies including government agencies such as the Nigerian Secondary Schools Project (NSSP) by the defunct CESAC; the Nigerian Integrated Science Project (NISP) in 1971 by STAN; the Primary Education Improvement Project: Northern States Primary School Project (NSPSP) by the institute of Education, Ahmadu Bello University (ABU), Zaria etc. to fully participate in many other science curriculum development projects both at the primary and secondary levels of the educational system. This brought about the emergence of new National Policy on Education (NPE) of 1977 revised in 1981. However, the bottom-line of these curricular reform efforts hinged on the fact that there was total dissatisfaction with how science was being taught using lecture method. The traditional approach prompted the decreasing popularity of science among students as evidenced by the declining number of students choosing science subjects (Ojimba, 2013).

At the post-secondary school level, the establishment of Yaba College in 1932, later upgraded to Yaba College of Technology in 1963, to run courses in engineering, medicine, science, agriculture, survey and teacher training was meant to fill vacancies in relevant government developments as noted by Martins Library BlogSpot (2013). The college also produced the first set of graduates who taught science in secondary schools and played major role in laying the foundation for the development of appropriate curriculum for science in the secondary schools.

Another giant stride in the development of post-secondary school science education is the establishment of the University College at Ibadan in 1948 as University of London following the report of the Elliot Commission for Higher Education set up in 1943. The University College remained with status of the University of London up to 1960 when it started awarding its own degree and became University of Ibadan in 1962. These colleges later became Obafemi Awolowo University (OAU) in 1962, Ahmadu Bello University (ABU) 1962 and University of Nigeria Nsukka in 1960 respectively.

2.2.1 Philosophy and Objectives of Science Education in Nigeria.

The potency of science education is globally recognized by governments having realized its relevance in improving the nation's technological and industrial development. According to Ibrahim (2012), science education as a subject may simply be viewed as education for the development and acquisition of scientific knowledge and literacy. This is in order for the members of the society to be able to explain scientific phenomena for the promotion of a very sound technological and economic breakthrough as well as the upkeep of a steady manpower output. Ogunmade (2005) sees science education as a field of study concerned with producing a scientifically literate society and laying the foundation for future work in science and science-related fields by acquainting the students with certain basic knowledge, skills and attitudes. Ado (2012) observed that the Federal Government of Nigeria via the Ministry of Education has outlined a number of objectives for secondary education in the National Policy of Education, and therefore whatever is taught in secondary school science must be directed towards realizing the broad national objectives for secondary education. These objectives include the following:

Secondary Schools in Nigeria should:

- i. provide an increasing number of primary school pupils with the opportunities for education of higher quality irrespective of sex or social, religious and ethnic background;
- ii. cater for the differences in talents, opportunities and roles possessed by or open to students after their secondary school courses through diversification of the school curriculum.
- iii. equip students to live effectively in the modern age of science and technology; and
- iv. raise a generation of people who can think for themselves, respect the views and feelings of others, respect the dignity of labour and appreciate these values specified under that broad national aims of education and live as good citizens.

According to Bell, Blair, Crawford and Lederman (2003) an adequate understanding of the nature of science and scientific inquiry is the main instructional purpose of science education. Ogunmade (2005) however noted that researchers and science educators such as Cobern (1994), Bajah (1998), Oversby (1998), and organizations such as UNESCO (1994) and National Research Council (NRC) (1996) have over a decade presented several conflicting perspectives on the purpose and goals of science education. Their views about the purpose and goals of science education include the following:

- i. Developing creativity in learners;
- ii. Improving scientific literacy and technological literacy of citizens;
- iii. Preparing citizens for an active contribution towards their own culture; and
- iv. Inculcating the spirit of scientific thinking in learners.

According to Ogunmade (2005), the American Association for the Advancement of Science (AAAS) had in 1989 argued that an understanding of science concepts and principles is crucial

to developing scientific literacy and also for meaningful and productive careers in science and thus asserting that more and more jobs today require people who have the ability to learn, reason, think, make decisions and solve problems as well as engage in scientific discourse. Ojimba (2013) added that the AAAS in 1985 and 1993 established a curriculum reform project code-named “Project 2061” and the conceptual basis for the reform has some basic features with the following aims:

- i. To achieve scientific literacy as the central goal of science education focusing on the students’ understanding of the nature of science by the study of its history and philosophy.
- ii. To relate an understanding of major concepts, principles and habits of thinking in science, mathematics and technology to events or activities in the society.
- iii. To achieve science standard for all students including girls, language, ethnic minorities and all ability groups in an attempt to encourage all students to succeed and to embrace excellence and equity.
- iv. To design science education to reflect that science is an active process, so that both hands-on as well as minds-on activities should constitute the core of the education process by teaching less content with greater depth of understanding.
- v. To focus on inquiry as a central element of the curriculum to promote students to actively develop their understanding of scientific concepts, along with reasoning and thinking skills, through group based approaches and greater cooperation among science teachers and students while deemphasizing competition in the classrooms.
- vi. To explore the use of alternative assessment techniques to paper and pencil tests.

The AAAS' assertion concurs with the goals for science education enumerated in the report of the National Research Council (NRC) (1996) that the knowledge of science concepts and principles would help students to be able to:

- i. experience the richness and excitement of knowing about and understanding the natural world;
- ii. use appropriate scientific processes and principles in making personal decisions;
- iii. engage intelligently in public discourse and debate about matters of scientific and technological concern; and
- iv. increase their economic productivity through the use of the knowledge, understanding, and skills of the scientifically literate person in their careers.

The NRC (1996) summed it all up by saying that scientifically literate persons are those who can think, ask questions, and provide logical and coherent answers to any situations and everyday experiences. Likewise, Craven & Penick (2001) noted that a scientifically literate student develops higher-order cognitive thinking to identify and evaluate ill-defined problems, to make informed decisions, and also to provide a variety of solutions to any particular problem. Therefore, Ogunmade (2005) summed it up that understanding the nature of science and scientific inquiry to foster learners' ability to develop scientific literacy is the purpose and goal for science education.

2.3 Teaching of Chemistry at Senior Secondary School Level.

Chemistry is one of the important subjects in science, not only because of its numerous and fundamental connections with other branches of science, but also because of its wide ranging influence on the way humans live. Majek (2008) views chemistry as the science of materials in the natural and that it is pivotal to the development, sustainable use and appropriate management

of the built and natural world. Chemistry is one of the means by which humans describe reality. It deals with the chemical nature of the substances making up the environment and with the changes these substances undergo. Chemistry comprises four components namely the processes used to acquire chemical knowledge; the general concepts and specific ideas so produced. It also comprises the applications of that knowledge in creating changes that improve the quality of human life; and the implications of such understanding and change for individuals and societies (Cheng & Gilbert, 2009). Cheng & Gilbert, (2009) also argued that understanding chemistry require the understanding of the nature of chemistry, its methods, theories, concepts and how chemistry and chemistry-based technologies relate to each other, alongside the understanding and appreciation of the impact of such chemistry-related technologies on society.

Chemistry contributes to the development of students' scientific literacy (Mumber & Hunter, 2009) and provides a concrete foundation for further studies or careers. Generally, the broad aims of chemistry curriculum stated for example, by the United Kingdom Curriculum Development Council (1996) are to enable students to:

- i. develop interest and maintain a sense of awareness and curiosity about chemistry;
- ii. construct and apply knowledge of chemistry, and appreciate the relationship between chemistry and other disciplines;
- iii. understand and appreciate the evolutionary nature of science, especially chemistry
- iv. develop skills for making scientific inquiries;
- v. develop the ability to think scientifically, critically and creatively and solve problem individually and collaboratively in chemistry-related contexts;
- vi. discuss science - related issues using the language of chemistry;
- vii. make informed decisions and judgments on chemistry-related issues and develop open-mindedness and objectivity in doing science.

- viii. show appropriate awareness of working safely, especially in a chemical laboratory setting
- ix. understand and evaluate the social, ethical, economic, environmental and technological implications of chemistry; and develop an attitude of responsible citizenship based on such understanding.

The revised edition of the Nigerian Senior Secondary School Chemistry Curriculum (Federal Ministry of Education, 2007) expects among other things that chemistry should enable students to:

- i. develop interest in the subject-matter of chemistry;
- ii. acquire basic theoretical and practical knowledge and skills in chemistry;
- iii. develop interest in science, technology and mathematics;
- iv. acquire basic science technology and mathematics knowledge and skills;
- v. develop reasonable level of competence in Information Communication Technology applications that will engender entrepreneurial skills;
- vi. apply skills to meet societal needs of creating employment and wealth;
- vii. be positioned to take advantage of the numerous career opportunities offered in chemistry;
- viii. be adequately prepared for further studies in chemistry.

In addition, it is expected according to Federal Ministry Education, (2007) that the revised curriculum should:

- i. facilitate a smooth transition in the use of scientific concepts and techniques acquired in the new Basic Science and Technology curriculum with chemistry;
- ii. provide students with the basic knowledge in chemical concepts and principles through efficient selection of contents and sequencing; Show chemistry in its inter-relationship with other subjects;

- iii. show chemistry and its link with industry, everyday life activities and the inherent hazards;
- iv. provide a course which is complete for students not proceeding to higher education while at the same time provides a reasonably adequate foundation for a post-secondary chemistry course.

When compared to other curriculum documents, it is evident that the Nigerian chemistry curriculum does not highlight opportunities for students to develop chemical literacy and apply their knowledge for personal decisions when faced with everyday issues and problems. Internationally, it is generally accepted by researchers and educators (Hattie, 2005; Loughran, 2006) that science and chemistry in particular, need to be taught in an engaging ways. However, chemistry has been predominantly taught over the last forty years in a traditional lecture approach (McRobbie & Tobin, 1995). The focus has been to cover the curriculum which often involves well-structured problems, mechanical and algorithmic laboratory work alongside a body of knowledge to be learnt by the students (Shymansky, 2003). Students often have difficulty understanding the relevance of the content to their everyday lives when it is presented in this kind of impersonal manner.

Furthermore, research studies have shown that students in Nigerian secondary schools have difficulties in learning chemical concepts and sometimes find the subject boring (Keshinro, 1998; Odubunmi, 1997; Olaleye, 2005; Olaleye, Adewumi and Akinniyi, 2008; Salau, 1996). A common theme emerging from these studies is that students' perceive chemistry as a subject that demands much effort for little success and they therefore tend to believe that the only way to pass examinations is by rote learning. Also, chemistry is not made relevant to their lives and does not encourage independent learning since the teaching tends to be more characterized by the chalk-and-talk method with little or no activities. Teachers present a typically theoretical teacher-

directed and lessons resulting in students not having a deep understanding of the concepts taught less the implications or the applications of such concepts or knowledge for the personal life and development.

In making efforts to reform chemistry teaching and learning in Nigeria, various studies have been carried out with the aim of improving student's performance and attitudes towards chemistry. Research studies in Nigeria indicate that teachers in Nigeria are faced with problems of large classes and they lack adequate resources to make concepts concrete and understandable to students (Aderounmu, Aworanti & Kasali, 2007). Despite various suggestions for improvement, the low standard of instructional efficiency remains (Ogunmade, 2006; Akintunde & Lawal, 2008; Olaleye, 2009). From these perspectives, it appears that the low standard of students' academic achievement could be attributed to the following factors:

1. Teachers' lack of necessary content or pedagogical knowledge needed to teach chemistry topics effectively.
2. Pressure to cover the curriculum content within a specified and limited period of time.
3. Preparing the students mostly for examination purposes.
4. Attempting to attain or achieve the objectives of course content or without necessarily being mindful of students gaining meaningful understanding of the course.

Cuttance (2001) argues that capturing students' interest in chemistry at senior secondary school level is a crucial aspect to improving the intake of chemistry students at tertiary levels. For this reason, it is often suggested by science educationist that there is a need to improve the way chemistry is taught in schools so that students are more engaged and recognize the relevance of science through a kind of real-life practical activities. Minds-on as well as hands-on activities that engage students in active learning are important in any chemistry classroom. Likewise, Njoku (2004) stressed that the teacher needs to be trained on how to use activities that will make

learners do and experience science instead of just reading about science. Contemporary learning theories indicate that students need to be actively engaged in learning tasks if they are to develop a meaningful understanding of chemistry.

2.3.1 The Senior Secondary School Chemistry Curriculum.

According to FRN (2013), the revised edition of the senior secondary school Chemistry curriculum is expected among other things to enable students to:

- i. develop interest in the subject of chemistry;
- ii. acquire basic theoretical and practical knowledge and skills;
- iii. develop interest in science, technology and mathematics;
- iv. acquire basic STM knowledge and skills;
- v. develop reasonable level of competence in ICT applications that will engender entrepreneurship skills;
- vi. apply skills to meet needs of creating employment and wealth;
- vii. be positioned to take advantage of the numerous career opportunities offered by chemistry;
- viii. be adequately prepared for further studies in chemistry.

In selecting the contents, three major issues shaping the development of nations worldwide, and influencing the world of knowledge today were identified as globalization, information/communication technology and entrepreneurship. The desire that Nigeria be identified with contemporary development worldwide has called for the organization of the contents of the chemistry curriculum around four themes of:

- i. The Chemical World
- ii. Chemistry and Environment
- iii. Chemistry and Industry

iv. Chemistry and Life

The Chemistry curriculum is divided into three sections, corresponding to the three years with senior secondary school level. The curriculum content for senior secondary year one (SS1), consists of seven units. These are separation techniques; particulate nature of matter; Chemical combination; Gaseous state and laws; Acids, Bases and salts; carbon and its compound; and industrial Chemistry. The curriculum content for senior secondary year two (SS2) consists of five units. These are particulate nature of matter (periodicity); Qualitative aspects of chemical reactions; Rates, Energy and Equilibrium; Non-metals and their compounds; Carbon and its compounds (Organic Chemistry 1). The content for senior secondary year three (SS3) consists of four units these are: wave/particulate nature of matter, metals and compounds, carbon and its compounds (Organic Chemistry II) and Space and Earth Chemistry. The curriculum is thus carefully structured to meet up with the objectives of Chemistry education. Hydrocarbon as concept in SSCE chemistry is under carbon and its compounds (Organic Chemistry I).

2.4 Students' Academic Performance in Chemistry at Senior Secondary Schools.

Academic performance in chemistry is an indication of the type of learning and the associated psycho-social environment in a teaching and learning process. Many studies have been carried out that identified factors that affect students' academic performance in chemistry. These factors range from class size, equipment and materials, laboratories, instructional facilities and strategies, lack of suitable textbooks, guidance and counseling services, academic and professional qualification of teachers in science (Oloyede, 2010).

Ajewole, Ajobasile and Okebukola (2000) observed that the quality of any educational programme is a function of the quality of those who teach it. They further opined that teachers' effectiveness is measured by how successful a teacher can impart knowledge and how much the students achieve in that process. They therefore, suggested that the professional training of

science teachers should be strengthened in the field of subject methodology. Akin (2008) also stated that any academic process in which excellence and requisite performance are required, qualified and committed teachers must be available both in quality and quantity. Akin (2008) further observed that class size is a major factor that contributes to the level of students' poor academic performance in chemistry across the schools. He pointed out that this represents one of the major problems in the teaching and learning of science especially chemistry. Most of the Nigerian secondary schools have students' enrolment of at least eighty students per class. This tends to place limitations on the provision of facilities for effective teaching and learning of science and also lowers students-teacher ratio. This also limits the level of teacher-student interaction thereby posing barriers on the way of the teachers to diagnose the students' learning difficulties.

Researchers such as Olajide, 2007; Lawal, 2007; and Atadoga, 2011 among others found that the persistent low academic performance in science subjects by students is attributable to large class size, constant use of lecture method, quality of professional service given teachers, especially at the pre-service level as well as students' poor understanding of basic concepts in science among others. Every child is born with certain potential in him or her and under conducive and enabling environment with relevant and appropriate instructional strategies, the tendency for their realization of their potentials and high academic achievement is high (Atadoga & Lakpini, 2013).

Shaibu (2000) noted that in classroom practice, a science teacher needs the use of one or more philosophy of science for effective teaching. He further observed that the basis of science teaching in this respect can be broadly viewed along the dimension of teachers' understanding of the meaning and nature of science. He explained further that the meaningful teaching of science is partly based on a clear understanding of the meaning and nature of science the teacher has, as

effective teaching involve interaction between the teacher and the subject-matter in the areas of both the practical and theoretical context. Ayodele (1999) also noted student's negative attitude toward science learning which he said affect their academic performances. He further said that some of the contents taught in science often have no bearing with students' practical life or their goals and career aspirations.

2.4.1 Retention of Learnt Concepts and Academic Performance in Chemistry.

Retention of knowledge is a very important factor affecting teaching and learning of science. Permanent and meaningful learning is the ultimate target of educational endeavour (Bunkure, 2012). According to Bichi (2002), understanding and retention are products of meaningful learning when teaching is effective and meaningful to students. Hornby (2010) defined retention as the ability to remember things. Lawal (2009) viewed retention as the ability of the memory to store information which can be recalled sometime after exposure to series of instruction or training. Bunkure (2012) defined retention as the ability to retain and consequently remember things experienced or learned by an individual at a time. Retention takes place when learning is coded into memory. According to Bichi (2002), appropriate coding of incoming information provides the index that may be consulted so that retention takes place without an elaborate search in the memory lane. Bichi (2002) further stated that the nature of the material to be coded contributes to the level of retention. Several factors influence retention. Bichi (2002) also reported that learning improves retention while things that lead to confusion or interference among learned materials, decrease the speed and efficiency of learning and accelerates forgetting.

Several studies have been carried out by different researchers on retention, some of which include: Akinbobola and Folashade (2009) who compared the effectiveness of constructivist

teaching methods and the conventional method with reference to achievement, retention and attitude. They found that students exposed to constructivist teaching method had higher cognitive achievement, more positive attitude and higher retention level than those taught using the conventional teaching method. Ezeudu (1995) found that SSII Chemistry students taught using concept mapping teaching strategy retain organic concepts better than those taught with lecture method. Also, Anaekwe (1997) found out that students taught with Students' Interaction Pattern (SIP) with lecture method retain chemistry concepts better than those taught with lecture method only. From these reported literature, it has been shown that improved instruction could enhance retention. It is in line with these findings that this study is conceived to investigate whether the statements of behavioural objectives improve the quality of instruction and consequently enhancing retention of learnt materials.

2.5 Concept of Hydrocarbons.

Hydrocarbons are organic compounds composing of only carbon and hydrogen atoms in their molecules. For example, methane (CH_4), ethane (CH_3CH_3), ethene ($\text{CH}_2=\text{CH}_2$), ethyne ($\text{CH}\equiv\text{CH}$), and benzene (C_6H_6). Hydrocarbons can either be alkanes, which have carbon-carbon single bonds; alkenes, which contain at least one carbon-carbon double bond; or alkynes, which contain carbon-carbon triple bonds (Solomon & Fryhle, 2008). Hydrocarbons are energy-rich because of their high carbon content. They are burned in oxygen (combustion) to release their energy. Crude oil, or petroleum, is the main source of liquid hydrocarbons. Crude oil is a mixture of various hydrocarbons, which can be separated via fractional distillation. These components have distinct uses, from providing energy for cooking to lubricating machine parts. Natural gas mainly contains methane, which is the smallest hydrocarbon. Crude oil and natural gas formed over the course of millions of years from decomposed plants and animals buried underground.

Oil, natural gas and coal (which consist of carbon and various other elements) are fossil fuels. There are two groups of hydrocarbons; namely saturated and unsaturated hydrocarbons. In each case, the carbon atom has to maintain tetravalency in their molecules. In the saturated hydrocarbons i.e. the alkanes, all the four bonds around any carbon atom in the molecules are single bonds and in the unsaturated hydrocarbons (alkenes and alkynes), there are always carbon-carbon multiple bonds (double and triple bonds as the case maybe) in the molecule. The structure and naming of hydrocarbons serve as the foundation for other moving to similar tasks of organic compounds containing functional groups (Fessenden & Fessenden, 1990). Naming and drawing of hydrocarbons, like all other chemical concepts at the symbolic level are associated with some degree of learning difficulty with respect to such concepts as their structures, chemical equations, and reactions. Kozma (2000) stated that the name of a hydrocarbon compound can give induction about the different atoms present in the compound in question as well as its likely physical properties. Ege as cited in Kozma, (2000) stated that scientists cannot talk about Organic Chemistry and yet relegate structural diagrams to the background. That is, chemical scientists in the area of Organic Chemistry always draw molecular structures for the chemical reactions they talk about. This is because molecular structures of compounds help to identify the constituent atoms, the relative spatial arrangement of the atoms, and the chemical bonding between the atoms.

In Nigeria, hydrocarbon concept is taught in senior secondary school through to the university in subjects such as Chemistry. The West African Examination Council (WAEC) Chief Examiners' Reports have over the years reported on the low performance of candidates in chemistry at senior secondary school. This is particularly evident in the area of chemical concepts (WAEC, 2002; 2005; 2006; 2008; 2010). The Chief Examiner (CE) in 2005 observed that the number of

candidates who answered the question on Chemistry aspects was very low and such candidates showed poor performance in such areas. For instance, the candidates could not clearly show the difference between organic compounds in general and hydrocarbons. An empirical study by Adu-Gyamfi (2013) further exposed the weakness of senior secondary two (SSII) students in IUPAC nomenclature, identifying functional groups and determining correctly the homologous series of organic compounds. This identified weakness is common for both hydrocarbons and non-hydrocarbons such as alkanols, alkanolic acids, and alkyl alkanooates. Students' difficulties in organic compounds stem from the fact they could not identify the correct number of carbons in a continuous chain as well as any substituent group and its point of attachment to the respective carbon atoms.

2.6 Concept of Behavioural Objectives in Science Teaching.

Behavioural objectives, learning objectives, instructional objectives, and performance objectives are terms that refer to a description of observable students' behaviour in terms of expected performance outcome. At some point, almost every teacher, must deal with writing and using such objectives. In the classroom setting, such objectives are referred to as behavioural objectives. Efforts are made to assist student, student-teachers and other stakeholders in educational practice to understand better ways of stating behavioural objectives. That is, stating behavioural objectives to reflect what they do instead of indicating the learner's activities and behavioural changes expected resulting from such activities. The use of behavioural objectives has been seldom transferred to normal daily lesson preparations as stated by Bob (2002).

The initial work on the need to attend to observable student performance was done as early as 1919 by John Watson, but Ralph Tyler has been recognized as being the one who pioneered the work in the 1920's (Stedman, 1973). It was Tyler (1974) who recommended that an objective

statement should clarify the kind of behaviour a course or a lesson should develop among the students. Over the past years, different ideas about how best to express instructional intent have existed. These differing views have often created confusion for both students of teacher education and less experienced teachers. Due to the importance of behavioural objectives, Bob (2002) noted that at some point, almost every teacher, especially new teachers and student-teachers alike must learn to write behavioural objectives correctly. Jekayinfa (2002) asserted that acquiring the skill to write appropriate behavioural objectives is something that is necessary and important in the process of becoming an effective teacher. Obed (1987) viewed behavioural objectives as a proposed behaviour which the learner will pursue and acquire during the course of a lesson or a course and manifest in an observable manner when the student completes the lesson or course as the case may be.

According to Olawepo (1997), well-constructed behavioural objectives describe an intended learning outcome and contain three parts each of which alone means nothing, but when combined into a sentence or two, communicate the conditions under which the behaviour is performed. Those comprise of verb that defines the behaviour itself and the degree (criteria) to which a student must perform the behaviour. If any one of these components is missing, the objective cannot communicate accurately. In line with this, behavioural objectives should contain the following components as posited by Bob (2002).

Conditions: Refers to a statement that describes the condition under which the behaviour is to be performed. The conditions component of an objective specifies the circumstances and commands directions that the student is given to initiate the behaviour relevant to intend student-learning performance. The initiated behaviour of the student can best be understood within the context of the condition under which the behaviour is to be performed or demonstrated. Examples of the condition part of behavioural objectives usually start with this type of statements like:

Upon request the students should; Given (some physical object) the students should; At the end of the lesson, the students should...

It should be noted that there is no mention of the description of instruction that precedes the initiation of the behaviour. Hence there is concentration on describing only the conditions under which the desired students' behaviour is to be performed or displayed.

Behavioural verb: This is an action word that connotes observable student behaviour. Writing appropriate behavioural objectives starts with choosing appropriate verb or phrase. A behavioural verb describes an observable product or action. In stating behavioural objectives, the verb is an action word: It is a special kind of action word that leads to a destination. Behavioural verb are action words that mean an observable behaviour. For instance, the teacher may intend to make students appreciate or understand or know one thing or another. It is impossible to see when a student appreciates, understands or know something. What can be done is to make inferences that a student appreciates, understands or knows something based on what the student does or says in a controlled situation.

Among the verbs that cannot and should not be used when stating objectives as stated by Bob (2002) include the following: to appreciate, acquire, know, understand, have mastery of, believe in, grasp the significance of etc.

These verbs or phrases have certain features in common and the most obvious ones are:

- (1) These verbs are imprecise
- (2) They refer to non-observable behaviour which is difficult if not impossible to evaluate or measure.

Teachers are therefore advised not to use them when expressing behavioural objectives.

The following verbs and their definition as also stated by Bob (2002) can be helpful when writing behavioural objectives.

- i. **DEFINE:** To stipulate the requirement for inclusion of an object, word, or situation in a category or class.
- ii. **CONSTRUCT:** To make a drawing, structure or model that identifies a designated object or set of condition.
- iii. **MEASURE:** To apply a standard scale or measuring device to objects, or conditions, according to practices accepted by those who are skilled in use of the device or scale.
- iv. **CLASSIFY:** To place object, word, or situation into categories according to defined criteria for each category. The criteria must be made known to the students.
- v. **DISTINGUISH:** To identify under conditions when only two contrasting identifications are involved for each response.
- vi. **APPLY A RULE:** To state a rule as it's applies to a situation object or even that is being analyzed. The statement must convey analysis of a problem situation and or its solution, together with the name or statement of the rule that was applied.
- vii. **NAME:** To supply the correct name, in oral or written form of an object, class of object, persons, places, conditions, or events which are pointed out or described.
- viii. **DIAGRAM:** To construct a drawing with label and with a specified organization or structure. Graphing, use of charts and maps are types of diagramming, and these terms may be used where more exact communication of the structure of the used situation and response is desired.
- ix. **DESCRIBE:** To name all the necessary categories of objects, object properties, or event properties that are relevant to the description of designated situations.
- x. **EVALUATE:** To classify objects, situations, people, conditions, etc.; according to defined criteria of quality.

Criteria: This refers to a statement that specifies how well the student must perform the stated behaviour. The criteria component of a behavioural objective is a declarative statement that describes how well the behaviour must be performed to satisfy the intent of the behaviour verb (Obed, 1987). It should be clear that criteria are expressed in some minimum number or as what must be, as a minimum included in a student's response.

A behavioural objective is a major focal point of a lesson plan (Okunlayo 2001). It provides criteria for constructing an assessment for the lesson as well as for the instructional procedure the teacher designs to implement the lesson. It should be the goal of teachers as well as students to understand in more than one way the content to be learned. In other words, the teacher who prepares objectives as part of lesson plan should have more than superficial knowledge of the appropriate content. Inconsistency with the body of content in writing objective is expected to be avoided. This is because it is considered a mere waste of time by Association of College and Research Libraries (2001).

2.7 Overview of Similar Studies.

Studies have been carried out to investigate the effect of behavioural objectives in various subject areas. Some of these studies include Bamidele (2004) who investigated the effects of prior knowledge of behavioural objectives on mixed-sex and single-sex grouping strategies in Nsukka Local Government Area of Enugu State; Osuafor (2016) investigated the effect of prior knowledge of behavioural objectives on Mathematics achievement of high and low mental ability secondary school students in Imo state, Nigeria.. One of the problems with a great deal of the studies lies in what is meant by "behavioural objectives". Some studies like Osuafor (2016) employ objectives like that are more precise than others. Others like Chukelu (2013) fail to define what sort of objectives they have employed and still others differentiate and compare different types of objectives. As a result, it is difficult to generalize across board in the findings

of the studies. Although some points are generally agreed upon, one of this is the fact that all types of objectives have one common characteristic, namely the possession of an action verb. These studies also cut across various fields of science including study of Babalola (2010) in Biology, Bamidele (2004) in Chemistry, Chukwuneka (2012) in Physics and Osuafor (2016) in Mathematics; and also across various educational levels including primary, junior secondary, Senior Secondary; Colleges of Education and Universities; as well as across different geographical locations within Nigeria and abroad.

Bamidele (2004) investigated the effects of prior knowledge of behavioural objectives on mixed and single sex grouping strategies among SS 2 Chemistry students in Nsukka Local Government Area of Enugu State. The design of the study was the randomized post-test-only control group design. A sample of 84 (SS 2) female students offering Chemistry from a coeducational secondary school in Enugu, Nigeria participated in the study. The instruments for data collection were Chemistry Practical Test (CPT) and Chemistry Practical Skills Rating Scale (CPSRS). The data collected were analyzed using mean, standard deviation and t-test statistic. The results revealed that girls in single-sex group scored significantly higher mean than mixed-sex group. This was accounted for by the fact that in coeducational science classrooms, boys tend to dominate the learning activities especially during practical work. Therefore, the present study unlike Bamidele (2004) investigated the influence of knowledge of behavioural objectives on academic achievement and retention of Secondary School Chemistry students' in Giwa Education Zone, Kaduna State, Nigeria.

Oloyede (2006) studied the effects of prior knowledge of behavioural objectives on academic performance among senior secondary chemistry students in Nsukka Local Government Area of Enugu State. The design of the study was quasi-experimental, employing the

nonequivalent pretest posttest control group design. The population consists of 876 public senior secondary school students in the state. The sample size of the study was 150 SS1 chemistry students from three coeducational schools randomly drawn from 17 coeducational secondary schools in Nsukka. Intact classes were assigned to one experimental group and a control group. Students in the experimental were taught with prior knowledge of behavioural objectives while those in the control group were taught using lecture method without prior knowledge of behavioural objectives. The instrument used for data collection was Mass-mole Performance Test (MPT). Data obtained were analyzed using mean and standard deviation to answer the research questions and Analysis of Covariance (ANCOVA) to test the hypotheses at 0.05 level of significance. The findings of the study showed that Prior knowledge of behavioural objectives approach resulted into higher students' scores in performance in chemistry. The present study unlike Oleyede (2006) examined the influence of knowledge of behavioural objectives on academic performance and retention of Secondary School Chemistry students' in Giwa Education Zone, Kaduna State, Nigeria.

In Mathematics, Asiyari (2009) investigated the impact of prior knowledge of behavioural objectives on sixth grade students' achievement and attitude toward mathematics in Central Anatolia Region. The study was carried out in a public school in one of the towns of the Central Anatolia Region with 28 sixth-grade elementary school students. One group pretest-posttest design was used. Mathematics Achievement Test (MAT) and Mathematics Attitude Scale (MAS) were administered to collect the necessary data. The instruction was given by the researcher five hours per week in a 15-week period. The data were analyzed by using one-way repeated measures Analysis of Variance (ANOVA) and a paired-samples t-test. It was found that there was a statistically significant change in mathematics achievement of the sixth grade

students who were exposed to prior knowledge of behavioural objectives before instruction over three time periods (pre-intervention, post-intervention, and follow-up). There was however, a statistically significant decrease in mean scores of attitudes toward mathematics from prior intervention to after intervention periods. The present research seeks to explore the influence of knowledge of behavioural objectives on academic performance and retention of Secondary School Chemistry students' in Giwa Education Zone, Kaduna State, Nigeria.

Ayogu and Atwood (2010) investigated the effect of prior knowledge of behavioural objectives on students' conceptual change on some difficult concepts in chemistry in Anambra State, Nigeria. Quasi experimental, non-equivalent control group design involving two intact classes was used. The target population was all SS2 Chemistry students in the study area and the sample size was 170 students from four secondary schools purposefully selected in Idemili South Local Government Area of Anambra State. A Teacher Made Chemistry Achievement Test (TMCAT) was used as the instrument drawn from some chemistry concepts namely; Electrolysis, Redox Reaction, Calculations involving Mass and Chemical Equilibrium. Analysis of Co-variance (ANCOVA) was used to test the null hypothesis. From the findings, it was observed that the experimental group subjects, which received instruction based on prior knowledge of behavioural objectives performed significantly better than the control group subjects that received instruction without prior knowledge of behavioural objectives, indicating that prior knowledge of behavioural objectives is more effective in enhancing meaningful learning among chemistry students than the Lecture method without prior knowledge of behavioural objectives. The present study is however interested in examining the effect of knowledge of behavioural objectives on academic performance and retention of Secondary School Chemistry students' in Giwa Education Zone, Kaduna State, Nigeria.

Babalola (2010) examined the effectiveness of prior knowledge of behavioural objectives on eleventh grade students' human circulatory system achievement. Two teachers and two classes with a total of 60 eleventh grade students participated in the study. One class for each teacher was assigned as experimental group and treated with prior knowledge of behavioural objectives and the other as control group and treated without prior knowledge of behavioural objectives. The Human Circulatory System Achievement Test (HCSAT) was used both as pretest and post-test to assess students' achievement on human circulatory system concepts. Analysis with ANOVA revealed that prior knowledge of behavioural objectives before instruction improved students' achievement in human circulatory system compared to traditional instruction without prior knowledge of behavioural objectives. The present research differs however, by examining the influence of knowledge of behavioural objectives on academic performance and retention of Secondary School Chemistry students' in Giwa Education Zone, Kaduna State, Nigeria.

Usman (2011) worked on the effects of prior knowledge of behavioural objectives on Biology practical activities on secondary school students' in Abuja Municipal Area Council. The design of the study was quasi-experimental, employing the pretest, posttest non-equivalent control group design. A sample of 111 senior secondary one (SS1) Biology students randomly drawn from two coeducational schools was used for the study. The instrument used for data collection was Biology Performance Test (BTT). The data collected were analyzed using mean, standard deviation and Analysis of Covariance (ANCOVA) at 0.05 level of significance. The results revealed that practical activity method with Prior knowledge of behavioural objectives was more effective in fostering students' performance than the lecture method without Prior knowledge of behavioural objectives implying that Prior knowledge of behavioural objectives

enhance understanding of biological concepts by the learner. There was no significant difference in the mean performance score of male and female students taught biology using the Prior knowledge of behavioural objectives and gender on students' performance was not significant. The present study differs from Usman (2011) by investigating the influence of knowledge of behavioural objectives on academic performance and retention of Secondary School Chemistry students' in Giwa Education Zone, Kaduna State, Nigeria.

In Physics, Chukwuneka (2012) conducted a study on the effect of prior knowledge of behavioural objectives on the academic achievement, retention and attitude to physics among secondary school students of varied ability levels in Kano State, Nigeria. The study was quasi-experimental, employing the pretest-posttest control group design. A simple random sampling technique was used to select 4 schools out of 7 Science Senior Secondary Schools in Kano State. 160 out of 1559 SS II Physics students were used for the study. Physics Achievement Test (PAT) and Physics Attitude Questionnaire (PAQ) were used to collect data. The reliability of the PAT was calculated using Pearson's Product Moment Correlation Coefficient (PPMc) to be 0.86. Six null hypotheses were tested at $p \leq 0.05$ level significance using t-test, one-way Analysis of Variance (ANOVA), and Mann Whitney U test statistics. The findings revealed that students exposed to prior knowledge of behavioural objectives achieved more, retained the learnt concepts and developed more positive attitude to physics than their counterparts not so exposed to prior knowledge of behavioural objectives; there is no significant difference in students' achievement with reference to gender; and the strategy is suitable for students of varied ability levels. The present study differs however, by focusing on the influence of prior knowledge of behavioural objectives on academic performance and retention of Secondary School Chemistry students' in Giwa Education Zone, Kaduna State, Nigeria.

In another Physics study conducted by Chukelu (2013), the effects of prior knowledge of behavioural objectives and guided inquiry on learning outcomes of low achieving secondary school physics students in Kaduna Metropolis. The population consisted of 1,714 SS2 students and subjects were made into experimental and control groups. Quasi-experimental control group design consisting of pretest and post-test was used as the design for the study. Ninety-one low achieving students were randomly selected as the sample of the study. The experimental group was taught with prior knowledge of behavioural objectives and inquiry method while the control group was taught with inquiry method without prior knowledge of behavioural objectives. After using t-test and Wilcoxon statistics to analyze his data, the result showed that low achieving students taught physics concepts using the inquiry method and prior knowledge of behavioural objectives achieved significantly higher than those taught using inquiry method without prior knowledge of behavioural objectives and the attitude of the experimental group subjects had greatly improved. The study also revealed that guided inquiry method with prior knowledge of behavioural objectives favoured both male and female low achieving Physics students. The present study focuses however, on the influence of knowledge of behavioural objectives on academic performance and retention of Secondary School Chemistry students' in Giwa Education Zone, Kaduna State, Nigeria.

Dahiru (2013) investigated the effects of prior knowledge of behavioural objectives on academic performance in Integrated Sciences among junior secondary school two (JSS2) students using Amma International Secondary School, Potiskum as a case study. The design was quasi-experimental employing the pretest, posttest control group design. The population of the study comprised 70 students. The study involved two groups which were both taught using activity-based method. However, the experimental group involved small class-size interaction with prior knowledge of behavioural objectives while the control group involved large class-size

interaction. The instrument used for data collection was Students' Achievement Test (SAT). The data collected were subjected to statistical analyses using t-test to test the hypotheses at 0.05 level of significance. The findings revealed that students taught with prior knowledge of behavioural objectives using small class-size interaction achieved more than the students taught without prior knowledge of behavioural objectives using large class-size interaction implying that the use of prior knowledge of behavioural objectives and small class-size (group) interaction in practical classes (activities) enhances the students' academic performance. The present research differs from Dahiru (2013) as it examines the influence of knowledge of behavioural objectives on academic performance and retention of Secondary School Chemistry students' in Giwa Education Zone, Kaduna State, Nigeria.

In another study, Duniya (2014) examined the effects of practical activity method with prior knowledge of behavioural objectives on SS2 Students' academic performance from selected senior secondary schools in Sabon-Gari Local Government Area of Kaduna State. The design of the study was quasi-experimental, employing the pretest, posttest non-equivalent control group design. The population comprised all the 2,636 SS2 Biology students from 12 public senior secondary schools in the Local Government Area. A Sample of 60 students randomly drawn from two coeducational schools was used for the study. The experimental group was taught Animal Nutrition concepts using the practical activity method with prior knowledge of behavioural objectives while the control group subjects were exposed to practical activity method without prior knowledge of behavioural objectives. The instrument Student Performance Test (SPT) was used for data collection. The data collected were analyzed using mean, standard deviation and t-test at 0.05 level of significance. The results show that practical activity method with prior knowledge of behavioural objectives was more effective in fostering students'

academic performance than practical activity method without prior knowledge of behavioural objectives and the practical activity method with prior knowledge of behavioural objectives fostered the academic performance in females more than in males although, the difference was not significant. The present study differs from Duniya (2014) as it seeks to investigate the influence of knowledge of behavioural objectives on academic performance and retention of Secondary School Chemistry students' in Giwa Education Zone, Kaduna State, Nigeria.

Abel (2014) carried out a study on the effectiveness of prior knowledge of behavioural objectives on secondary school students' performance and motivation in Physics in Nyeri County, Kenya. The study adopted a Quasi-Experimental Research Design. Solomon-Four Non-equivalent Groups Design was involved. Stratified random sampling technique was used to select four boys' and four girls' county secondary schools in Nyeri, County. The four schools in each category were assigned to treatment and control groups by simple random sampling technique. Each group had one boys' and one girls' county secondary school. Each school provided one form two class for the study and a total of 370 students were involved. Students in all the groups were taught the same physics content but the experimental groups were taught with prior knowledge of behavioural objectives while the control groups were taught through Regular Teaching Methods (RTM) such as lecture method and teacher demonstrations without prior knowledge of behavioural objectives. The experimental group I and the control group II were pre-tested prior to the implementation of prior knowledge of behavioural objectives treatment. After four weeks, all the four groups were post-tested using the Students' Physics Achievement Test (SPAT). The instruments were scored and data was analyzed using t-test, one way ANOVA and ANCOVA at a significance level of 0.05. The findings of the study showed that Prior knowledge of behavioural objectives approach resulted into higher students' scores in

achievement in physics. It is however, the aim of this research to determine the influence of knowledge of behavioural objectives on academic performance and retention of Secondary School Chemistry students' in Giwa Education Zone, Kaduna State, Nigeria.

In a study carried out by Eniayeju (2015), the impact of prior knowledge of behavioural objectives on attitude, retention and performance in genetics among pre-NCE Biology students of different ability levels in North-West Zone, Nigeria. The research design was Quasi-experimental and control group design employing pretest and posttest and post-posttest. The population was 2,231 pre-NCE Biology students of Colleges of Education in the North-Western Nigeria which covers Katsina, Kaduna, Jigawa, Kebbi, Kano, Sokoto and Zamfara. The sample comprised of 110 students selected from two out of the eleven coeducational colleges of education that constitute the population of the study. Two instruments, namely: Genetics Academic Performance Test (GAPT) and Students Attitude to Genetics Questionnaire (SAGQ) were used for data collection. Pretest was administered to the subjects before they were exposed to the treatment and the ability grouping was carried out by categorizing the subjects into high, average and low groups based on their pretest scores. The experimental group was exposed to prior knowledge of behavioural objectives while the control group was exposed to lecture method without prior knowledge of behavioural objectives. The posttest was given to both groups to determine the effects of the treatments and post-posttest was administered after two weeks to determine retention. Data obtained were analyzed using Mean scores, Two-way Analysis of Variance (ANOVA) and Kruskal Wallis test statistics at $P \leq 0.05$ level of significance. The findings of the study showed that pre-NCE Biology students exposed to prior knowledge of behavioural objectives in the teaching and learning of genetics concepts in all the ability levels had higher mean performance scores and also retained more than those in the control group exposed to lecture method of instruction without prior knowledge of behavioural

objectives. Males and females in all the ability groups exposed to prior knowledge of behavioural objectives performed equally well and had also no difference in their retention abilities. The attitude of the experimental group also improved significantly in all the three ability levels. The present study unlike Eniayeju (2015) shall investigate the influence of knowledge of behavioural objectives on academic performance and retention of Secondary School Chemistry students' in Giwa Education Zone, Kaduna State, Nigeria.

Ibe (2016) investigated the impact of prior knowledge of behavioural objectives on questioning style preference and academic performance among senior secondary school II Chemistry students in Katsina Metropolis, Nigeria. A Quasi-experimental pretest and posttest research design was used for the study which featured two groups (Experimental and Control group). The sample consisted of 164 students selected from two secondary schools in Katsina Metropolis which was drawn from a population of 10 schools with a total of 753 students. The Instrument used was Chemistry Performance Test (CPT). The data collected were analyzed using t-test Statistic, ANOVA, ANCOVA and Scheff's test at significance level of $P \leq 0.05$. The results indicated that the experimental group which was exposed to the prior knowledge of behavioural objectives performed significantly better than the control group which was taught without prior knowledge of behavioural objectives. The treatment has no significant effect on gender which implied that prior knowledge of behavioural objectives is gender friendly. Finally, there is no significant difference between male and female students' cognitive questioning preference when exposed to prior knowledge of behavioural objectives. Thus, indicating that prior knowledge of behavioural objectives is gender sensitive as it is suitable for both male and female subjects. However, the present research differs from Ibe (2016) as it seeks to investigate the influence of

knowledge of behavioural objectives on academic performance and retention of Secondary School Chemistry students' in Giwa Education Zone, Kaduna State, Nigeria.

Osuafor (2016) investigated the effect of prior knowledge of behavioural objectives on Mathematics achievement of high and low mental ability secondary school students in Imo state, Nigeria. The research design adopted was Quasi-experimental non-equivalent control group. The sample for the study was made of 94 Senior Secondary two (SSII) students with an average age of 15 years. Two intact classes were used for the study, and from the two schools chosen for the study; one intact class formed the experimental group and the other, the control group. Two instruments: Mathematics Achievement Test (MAT) and General Mental Ability Test (GMAT) were used for data collection. The instruments were face and content validated by experts. The reliability of MAT was established using Kuder Richardson formula 21(KR-21) and Cronbach alpha and were found to have internal consistency of 0.99 and 0.89 respectively. Mean scores was used to answer the research questions while Analysis of Co-variance (ANCOVA) was used to test the stated hypotheses at 0.05 level of significance The results showed that: high mental ability students who had prior knowledge of behavioural objectives performed significantly better than the high mental ability students who did not have prior knowledge of behavioural objectives. Low mental ability group who had prior knowledge of behavioural objectives performed significantly better than the low mental ability students who did not have prior knowledge of behavioural objectives. However, the present research differs from Osuafor (2016) as it seeks to investigate the influence of knowledge of behavioural objectives on academic performance and retention of Secondary School Chemistry students' in Giwa Education Zone, Kaduna State, Nigeria.

2.8 Implications of the Literature Reviewed for the Present Study.

The literature reviewed indicate the influence of knowledge of behavioural objectives on academic performance and retention of learnt materials among a variety of students across different educational levels and also across different subject areas in the sciences as well as different locations in the world. These studies indicate that the exposure to knowledge of behavioural objectives enhance academic performance among students in comparison to their counterparts not so exposed to knowledge of behavioural objectives.

However, it can be observed from the literature reviewed so far that not much has been made in the context of studies in Nigeria to examine the influence of knowledge of behavioural objectives on academic performance and retention of Secondary School chemistry students especially in Kaduna state, Nigeria. It is also evident from the literature reviewed that only very few research studies have been done that focus on students' poor academic performance in the difficult areas of Hydrocarbons.

Many studies such as Duniya (2014), Eniayeju (2015), Felicia and Peter (2016) among others reviewed how other researchers carried out their studies. For example, in the research design, while some researcher used Solomon four groups designed, others used quasi experimental research design. This lead to the researcher's choice of quasi experimental research design involving experimental and control groups. In addition, the review pointed out several methodologies, sampling technique, data analysis as well as problems encountered by the previous researchers with view of remediating the identified errors. Thus, this helps the researcher in the choice of random sampling technique and inferential statistic in verifying null hypotheses raised.

Most of the researchers conducted painstaking variables such as academic performance; very little study was conducted on other variables such as retention. This ushered the researcher with insight on choice of academic performance, and retention as variables of interest. Thus the study seeks to determine the influence of knowledge of behavioural objectives on academic performance and retention of secondary school chemistry students in Giwa education zone, Kaduna state.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

In this chapter, the procedure employed in collecting data is described. These include research design, sample and sampling procedure, instrumentation and a highlight of intended procedure for analyzing collected data. The chapter is presented under the following sub-headings:

3.2 Research Design

3.3 Population of the Study

3.4 Sample and Sampling Technique

3.5 Instrumentation

3.5.1 Concept selected for the Study

3.5.2 Instrument Used for Data Collection

3.5.3 Validity of the Instrument

3.6 Pilot Testing

3.6.1 Reliability Coefficient of the Instrument

3.6.2 Determination of item characteristics

3.7 Administration of Instrument

3.8 Procedure for Data Collection

3.9 Procedure for Data Analysis

3.2 Research Design

The research design adopted for this study is the pretest, posttest quasi-experimental control group design as proposed by Kerlinger (2000). This involves two groups namely, the experimental and control groups. The Experimental Group (EG) which were exposed to the knowledge of behavioural objectives for each lesson were taught the concept of Hydrocarbon designated as (X_1) in the research design. This will lasted for six (6) weeks. The Control Group (CG) which is not exposed to the knowledge of the behavioural objectives of the lessons (X_0) were also taught the same concepts as (X_1) for the same six weeks. Lecture method as instructional strategy was used for both groups. Also, the two groups were pretested to determine their academic equivalence. After treatment, the two groups were post-tested to determine the effect (if any) of knowledge of behavioural objectives on the experimental group in relation to the control group. The flow chart of the research design is illustrated below.

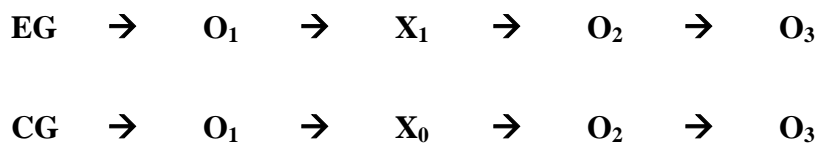


Figure 1: Research Design.

KEY

- EG - Experimental Group
- CG - Control Group
- O_1 - Pre-test on Academic Performance
- O_2 - Post-test on Academic Performance
- O_3 - Post-post test on Retention

X₁ - Treatment (Lecture method with knowledge of Behavioural objectives).

X₀ - Lecture Method (without knowledge of Behavioural Objectives)

3.3 Population of the Study

The population of the study comprises all senior secondary two (SSII) students studying chemistry in the fourteen (14) public senior secondary schools of Giwa education zone. Out of the fourteen schools, two (2) were single sex (female) while twelve (12) were Co-educational (mixed schools). Records from Giwa Zonal Education Board (2020), indicates that there are a total of six hundred and sixty-seven (667) senior secondary Chemistry students in these schools. Public day schools were used for the study. This is because their teaching and learning condition are relatively the same. These include such conditions as uniform condition of staff, class size, academic calendar, school environment, etc. SS II students were considered suitable for this study by virtue of their age and academic experience, since they must have already spent one year in the learning of senior secondary school chemistry as a subject. The chronological age range of the students is between 15-17 years. The details of the schools in the targeted population are presented in Table 3.1.

Table 3.1: Population of the Study

S/N	School	Type of School	Number of SS II chemistry students		
			Males	Females	Total
1.	GSS Basawa	Co-educational	36	33	69
2.	GSS Bomo	Co-educational	41	23	64
3.	GSS Hunkuyi	Co-educational	121	35	156
4.	GSS Jama'a	Co-educational	19	18	37
5.	GSS Kudan	Co-educational	63	34	97
6.	GSS Kwangila	Co-educational	38	15	53
7.	GSS Shika (Snr.)	Co-educational	38	14	52
8.	GSS Giwa	Co-educational	38	17	56
9.	GSS Yakawada	Co-educational	21	15	36
10.	GSS Fatika	Co-educational	26	14	40
11.	GSS Gangara	Co-educational	14	07	21
12.	GSS Sakadadi	Co-educational	19	06	25
13.	GGSS Samaru	Girls only	-	43	43
14.	GGSS Giwa	Girls only	-	48	48
Total			391	276	667

Source: Giwa Zonal Education Office (2020)

3.4 Sample and Sampling Technique

The sample for this study comprised one hundred and thirty-three (133) SSII Chemistry students' randomly selected from two public co-educational Senior Secondary Schools in Giwa Education Zone. The sampling was done as follows: Simple random sampling technique by balloting was used to select four (4) schools from the fourteen (14) public Senior Secondary Schools in the study area. The four schools selected were Government Secondary School Hunkuyi, Government Secondary School Basawa, Government Secondary School Giwa and Government Secondary School Shika (Snr). Simple random sampling is a sampling procedure which ensures that each element in a population has equal chance of being selected. Pre-test was administered to SS2 Chemistry students in each of the four schools randomly selected to determine their equivalence in terms of academic performance. This was achieved by subjecting the result obtained from the pre-test to One-Way Analysis of Variance (ANOVA) and Scheffe's test. One-Way ANOVA was used to determine the existence of any significant difference in the four schools while the Scheffe's Post Hoc test was used to separate the schools and figure out which schools were significantly or not significantly different. Three schools (G.S.S. Basawa, G.S.S. Bomo and G.S.S. Hunkuyi) showed no significant difference out of which two schools were randomly picked using the method of draw-from the hat random selection for the study.

The status of the schools (as experimental or control group) was determined using simple random sampling technique involving coin tossing. Before tossing the coin, the two schools were randomly assigned as head or tail in coin tossing process. It was then decided by the researcher that after the tossing whichever side of the coin that faced upwards was taken as the experimental group while the side facing downwards was taken as the control group. At the end of this exercise, school A eventually became the experimental group while school B became the control

group. Two intact classes one from the experimental school and one from the control school were drawn using balloting without replacement. This was done to ensure that every student in the schools had equal chance of participating in the study. Since all the schools in the population are at different locations, it was assumed that interaction among the subjects which could affect the results will not occur during the period of treatment. There are 69 SSII Chemistry students in the experimental group which comprises of 36 males and 33 females and 64 in the control group of which 41 were males and 23 females. The choice of the sample size for the study is in line with the Central Limit Theorem which recommended a minimum of thirty sample size as noted by Sambo (2008). This suggests that the minimum of 30 sample size is viable for experimental research. The detail of the sample for this study is shown in Table 3.2.

Table 3.2: Sample of the Study

S/N	Name of school	Males	Females	Status
1.	A	36	33	Experimental group
2.	B	41	23	Control group

3.5 Instrumentation

The process of instrumentation involved selection of sub-topics for the study, developing of instruments used for data collection, and validation of the instrument.

3.5.1 Concept Selected for the Study

The following concepts were selected from the Senior Secondary Education Curriculum developed by the Nigerian Educational Research and Development Council (2006), Hydrocarbon, Functional group, Alkane, Alkenes, Alkynes.

The choice of these concepts is considered suitable because they are among difficult areas students get to fail as reported by WAEC Chief Examiner (2019) and Ogenyi (2014). The concepts are the basic foundation of chemistry; therefore proper understanding of these concepts is very important for chemistry students. In addition, Ogenyi (2014) stated that students find these concepts difficult earlier because they were not taught in most cases or the teaching method used by the teachers was not appropriate.

3.5.2 Instrument Used for Data Collection

The Research instrument developed by the researcher for this study is the Hydrocarbon Concepts Performance Test (HCPT).

Hydrocarbon Concepts Performance Test (HCPT).

The instrument (Hydrocarbon Concepts Performance Test) consists of two (2) sections, A and B. Section A contains Students' Bio-Data (i.e. Name of School, Class, Age, and Gender) while section B consists of 40 multiple choice items to assess the performance of students in the Hydrocarbon concepts taught. The items were drawn from past WAEC Chemistry questions papers (2008-2017) by Anyaele (2017), Joint Admission and Matriculation Board (JAMB) question papers and Understanding Chemistry textbooks by Ojokuku (2011). The performance test was based on the objectives of the topics selected under Hydrocarbon as stated in the SS2 Chemistry syllabus. An example of how the questions were adapted is given below;

Topic: Hydrocarbon

Question 14: The hydrocarbon in which all the 4 valences of carbon are fully occupied is called:

- | | |
|-------------|-------------------|
| (a). Alkene | (c). Alkane |
| (b). Alkyne | (d). Cycloalkane. |

Answer = C

Topic: Alkane

Question 2: Methane is a member of the homologous series called:

- (a). Alkenes
(b). Alcohols
totally different.
- (c). Alkanes
(d). These compounds are not related at all, they are

Answer = C

The multiple choice item format was used because it allows for a wider range of coverage of the content and it is normally free of bias during marking. Each of the 40 multiple choice items consisted of four options (A-D), one of which is the correct answer and the others are distractors. Details of the items contained in this instrument are shown in Appendix A. The number of questions drawn and included for each topic is shown in Table 3.3.

Table 3.3: Item Specification for HCAT

Specific Area Covered	Item	Total
1. Hydrocarbon	(4, 14, 15, 23, 26, 33, 18, 30, 16, 24, 28)	11
2. Homologous series	(34, 36, 38, 40)	4
3. Alkanes	(1, 2, 10, 21, 9, 17, 29, 32)	8
4. Alkenes	(25, 6, 22, 35, 5, 20, 31)	7
5. Alkynes	(3, 7, 13, 19, 8, 37, 11, 27, 12, 39)	10
Total		40

3.5.3 Validity of the Instrument

The face and content validity of Hydrocarbon Concept Performance Test (HCPT) was achieved by presenting the instrument to a panel of experts comprising the following:

- i. Two science educators from the Department of Science Education (Chemistry), Ahmadu Bello University, Zaria, with minimum qualification of PhD each and rank of Senior Lecturer;
- ii. Two experienced secondary school Chemistry teachers with minimum qualification of B.Sc (Ed) Chemistry each with at least five (5) years teaching experience.

The experts were requested to examine the instrument and make comments as to whether:

- i. The instrument is of appropriate cognitive level for the target group.
- ii. The language, spellings, and the chemical symbols are correct.
- iii. Ambiguities and irrelevances that need to be deleted.
- iv. Additionally, they were also requested to make suggestions for improving the quality and appropriateness of the instrument items.

The suggestions so given and observations made include:

- i. Check the spelling of option D in item 1
- ii. In all the questions – the options that follow complete questions should start with capital letter.
- iii. Every option should end with full stop.
- iv. Items 1, 21 and 40 are testing the same concept. Replace or discard two.
- v. Option E of item 31 does not serve as a good distracter.
- vi. Items 19 and 26 are testing the same concept. Replace or discard one.
- vii. In item 23, two of the options are correct.

3.6 Pilot Testing

In order to refine the test item and to determine the reliability coefficient of the research instrument, split-half method was used. Pilot study was carried out in (Government Secondary School Giwa) one of the secondary school within the target population but not part of the school to be used for the main study. Hydrocarbon concepts performance test was administered to a group of thirty (30) students by the researcher. Instruction on how to answer the question was explained to the students where they had difficulties. This will be done to ensure that the students

answered the items carefully. Problems and difficulties arising from the pilot study will be carefully noted in order to improve upon the final instrument.

According to Bichi (2002), the purpose of pilot study is to determine the:

- i. Reliability coefficient of the instrument before administration.
- ii. Possible problem or difficulties that respondent may encounter with a view of eliminating them.
- iii. Appropriateness of the instrument.
- iv. Approximate time duration which the subject would need to answer the test items properly.

3.6.1 Reliability Coefficient of the Instrument

The data obtained from pilot testing was analyzed to establish the reliability of the instruments. The test re-test method was used to determine the reliability of Hydrocarbon Concept Performance Test (HCPT) within the interval of two weeks. The use of two weeks interval can be justified by the scholarly views of Tuckman (1975) and Sambo (2008) who proposed the interval of two or three weeks between first and second administration. Pearson Product Moment Correlation (PPMc) statistic was used to determine the reliability of the instruments. The reliability coefficient of HCPT was found to be 0.83. This indicates a higher reliability coefficient and therefore considered as quite suitable test items for the study.

3.6.2 Determination of item characteristics

(a). Facility indices of the items

The facility index (F.I.) is a measure of the ease of answering a test item. It indicates the percentage of candidates that got an item right (Tuckman, 1975; Sambo, 2008). The facility index of each of HCPT item was calculated using the formula proposed by Satterly (1986):

$$F.I. = \frac{R}{T} \text{ (Satterly, 1986)}$$

Where:

F.I.: Facility Index

R: Number of students who got an item correct.

T: The total number of students that sat for the test.

The F.I generally ranges from 0.1 - 1 and the higher the value, the easier the item. Items whose F.I range above 0.70 are considered very easy items and might be items not worth using. F.I that range below 0.30 indicate difficult items and should be reviewed as they may be too difficult for the cognitive level of the students. The recommended range is from 0.30-0.70. Items ranging below 0.30 or above 0.70 are considered too difficult or too easy respectively (Miller, Linn & Gronlund, 2009). For the present study, test items with facility indices ranging from 0.30 – 0.70 were considered appropriate and were therefore accepted for use. Items with facility indices ranging from 0.10 – 0.29 were considered too difficult and those with facility indices above 0.70 were considered too easy. These items were modified to suit the study or replaced. Details of the facility indices of test items for HCPT are presented in Appendix F.

(b). Discrimination indices of the items

The discrimination index (D.I.) of a test is a measure of its ability of an item to distinguish between high and low achievers in a test as a whole. It is the capacity of such a test to separate the high and low ranking students or the good and not so good achievers in the entire test. It is calculated using the formula proposed by Furst (1958) and Atadoga (2005):

$$D.I = \frac{RU - RL}{1/2 N} \text{ Frust (1958)}$$

Where:

D.I.: Discrimination Index

RU: The number among upper 27% of the respondents who scored item correctly.

RL: The number among lower 27% of the respondents who scored the item correctly.

N: The total number of respondents in each of the upper and lower groups.

As a rule in discrimination indices, 0.40 and greater are very good items; 0.30 to 0.39 are reasonably good but could possibly be subjected to improvement; 0.20 to 0.29 are marginal items and need some revision; while D.I at 0.19 and below are considered poor items and need major revision or elimination (Ebel & Frisbie, 1986). A negative discrimination index between -1.0 and 0.0 results when more students in the low group answered correctly than the student in the high group. Zero D.I means equal numbers of high and low students answered correctly, so the item did not discriminate between the groups. A positive D.I occurs when more students in the high group answered correctly than the low group. Discrimination indices ranging from 0.30 - 0.49 are described as moderately positive. Those between 0.50 - 0.70 and above are high positive values while those below 0.30 are described as low positive values. The index of discrimination HCPT falls within 0.30 - 0.70. Therefore, the discrimination indices are highly

positive, implying that the instrument is suitable for the study. The discrimination indices of all test items for each of HCPT are shown in Appendix F.

3.7 Administration of Instrument

The concept of Hydrocarbon was taught by the researcher to both the experimental and control groups for six weeks. Both groups were taught using the Conventional Method, however, the experimental group was provided with objectives of the lesson prior to the beginning of the lesson while the control group was not. The mode of instruction was the same for both groups except for the knowledge of the lesson that the experimental group had which the control group didn't. At the end of six weeks, the two groups were posttested to find out if knowledge of behavioural objectives or lack of it has any significant effect on academic performance of the two groups. Also, the same instrument i.e. HCPT were administered again to the two groups after two weeks to determine if knowledge of behavioural objectives of lessons has any significant effect on retention ability of the subjects in relation to concepts of hydrocarbons in chemistry.

3.7.1 Treatment of the Experimental Group

The experimental group was taught all selected concepts under Hydrocarbon by the researcher for six weeks of 80 minutes (double period) per week though instruction was done using the Conventional Method but the subjects were exposed to knowledge of behavioural objectives of each lesson before instruction. The instruction was purely expository and no instructional material was used. The difference in treatment between the experimental and control group was only the knowledge of behavioural objectives to the experimental group.

3.7.2 Teaching the Control Group

The students in the control group who are not exposed to the knowledge of behavioural objectives of the lessons were also taught using lecture method for six weeks.

3.8 Procedure for Data Collection

At the end of the treatment, study subjects were post-tested and data was collected through the following:

Hydrocarbon Concepts Performance Test (HCPT): A post-test was given and marked using the marking scheme (Appendix B). Data was collated after marking the students' scripts with a maximum score of 40. The scores were collated into experimental and control group. After sorting, the scores were fed into the Statistical Package for Social Sciences (SPSS) version 12.0 and subject to analysis. This was to determine if there is any significant difference in the academic achievement of the experimental and control group.

3.9 Procedure for Data Analysis

In order to highlight the intended procedure for data analysis, the research hypotheses are here under restated and appropriate statistical tool for testing each hypothesis are indicated accordingly. These will be tested at $P \leq 0.05$

HO₁: There is no significant difference between the Pretest and Posttest mean performance scores of chemistry students exposed to knowledge of behavioural objectives.

t-test statistics was used to test the hypothesis.

HO₂: There is no significant difference between the mean academic performance scores of male and female chemistry students exposed to knowledge of behavioural objectives of lesson.

The hypothesis was tested using t-test statistics.

HO₃: There is no significant difference between the mean academic performance scores of chemistry students exposed to knowledge of behavioural objectives before instruction and those not so exposed.

t-test statistics was used to test the hypothesis.

HO₄: There is no significant difference between the mean retention scores of chemistry students exposed to knowledge of behavioural objectives before instruction and those not so exposed.

The hypothesis was tested using t-test statistics

CHAPTER FOUR

DATA ANALYSIS, RESULTS AND DISCUSSION

4.1 Introduction

In this chapter, the results obtained from the analysis of the data collected and discussions of the results are presented. The Statistical Package for Social Sciences (SPSS) IBM 20th Edition was used for the analysis and the level of significance for retaining or rejecting the stated hypotheses was $P \leq 0.05$. The work is presented under the following subheadings;

4.2 Data Analysis and Presentation of the Results.

4.2.1 Answers to Research Questions and Testing Null Hypotheses

4.3 Summary of Findings

4.4 Discussion of the Findings.

4.2 Data Analysis and Presentation of the Results.

The data collected using the instrument (HCPT) from the experimental and control groups were analyzed and the results obtained were used to answer the following research questions.

4.2.1 Answers to Research Questions and Testing Null Hypotheses

Research Question One: What is the difference in the Pretest and Posttest mean performance scores of chemistry students exposed to knowledge of behavioural objectives?

To answer research question one, Mean and Standard Deviation as well as mean differences of pretest and posttest HCPT scores of students in the experimental group were computed and used.

The result is shown in Table 4.1:

Table 4.1: Mean and Standard Deviation Statistics of Pretest and Posttest HCPT Scores for Students in Experimental Group.

Variable	Test Group	N	Mean	Std	Std.Err	Mean Difference
Performance	Pretest	69	14.72	2.66	0.48	2.24
	Posttest	69	16.97	3.98	0.32	

Table 4.1 shows the results of the descriptive statistical analysis carried out to determine the mean difference between the Pretest and Posttest mean performance scores of the experimental group. Their mean Pretest and Posttest scores are 14.72 and 16.97 respectively with a mean difference of 2.24 in favour of the Posttest scores. This indicates some level of positive effect of knowledge of behavioural objective on the student's academic performance. Therefore, higher mean Posttest score is due to the treatment administered. To ascertain if the difference in the mean between Pretest and Posttest scores is statistically significant, the corresponding null hypothesis was tested using t-test statistical tool.

Null Hypothesis One: There is no significant difference in the Pretest and Post test mean performance scores of chemistry students exposed to knowledge of behavioural objectives.

Paired Sample t-test statistics at $P \leq 0.05$ was used to determine if there was any significant difference in the Pretest and Post test mean performance scores of chemistry students exposed to knowledge of behavioural objectives. A summary of Paired Sample t-test of the students' Academic Performance scores is presented in Table 4.2.

Table 4.2: Summary of t-test Analysis of Pretest and Posttest Mean Academic Performance Scores of Experimental Group.

Variable	Groups	N	Mean	Std difference	Mean	df	t-value	p	Remark
Performance	Pretest	69	14.72	2.66					
					2.24	68	3.98	0.02	Sig
	Posttest	64	16.97	3.98					

Significant at $P < 0.05$

Table 4.2 shows the outcome of the Paired Sample t test statistics for the Pretest and Posttest performance scores of the experimental group only. It is found that the difference between their pretest performance score of 14.72 and their posttest performance score (16.97) was statistically significant. This tends to show that the group benefitted from knowledge of behavioural knowledge in enhancing their academic performance. Consequently the stated hypothesis (H_{O1}) was rejected.

Research Question Two: What is the difference between the mean academic performance scores of male and female chemistry students exposed to knowledge of behavioural objectives of lesson?

To answer research question two, Mean and Standard Deviation as well as mean differences of pretest and posttest HCPT scores of male and female students in the experimental group were computed and used. The result is shown in Table 4.3:

Table 4.3: Mean and Standard Deviation Statistics of Pretest and Posttest HCPT Scores for Male and Female Students in Experimental Group.

Variable	Test Group	N	Mean	Std	Std. Err	Mean
Difference						
Performance	Male	36	6.44	1.91	0.48	0.33
	Female	33	6.77	1.62	0.32	

Table 4.3 shows the results of the descriptive statistical analysis carried out to determine the mean difference between the mean scores male and female students in the experimental group. Their mean Pretest and Posttest scores are 6.44 and 6.77 respectively with a mean difference of 0.33 in favour of the Posttest scores. This indicates some level of positive effect of knowledge of behavioural objective on the female student's academic performance. Therefore, higher mean Posttest score is due to the treatment administered. To ascertain if the difference in the mean between Pretest and Posttest scores of male and female chemistry students exposed to knowledge of behavioural objectives of lesson is statistically significant, the corresponding null hypothesis was tested using t-test statistical tool.

Null Hypothesis Two: There is no significant difference between the mean academic performance scores of male and female chemistry students exposed to knowledge of behavioural objectives of lesson.

Paired Sample t-test statistics at $P \leq 0.05$ was used to determine if there was any significant difference in the Pretest and Post test mean performance scores of male and female chemistry students exposed to knowledge of behavioural objectives. A summary of Paired Sample t-test of the students' Academic Performance scores is presented in Table 4.4.

Table 4.4: Summary of t-test Analysis of Pretest and Posttest Mean Academic Performance Scores of Male and Female Students in Experimental Group.

Variable	Groups	N	Mean	Std difference	Mean	df	t-value	p	Remark
Performance	Male	36	13.19	2.94					
					1.12	52	-0.69	0.496	Not Sig
	Female	33	13.75	2.81					

Not significant at $P < 0.05$

Table 4.4 reveals a p-value of 0.496 observed at degree of freedom of 52. This p-value is greater than the 0.05 level of significance indicating that there is no significance difference between the mean academic performance scores of male and female students exposed to knowledge of behavioural objectives before instruction. Hence, the null hypothesis is retained, implying that gender does not significantly influence secondary school Chemistry student's academic performance in Hydrocarbon when exposed to knowledge of behavioural objectives.

Research Question Three: What is the difference between the mean academic performance scores of chemistry students exposed to knowledge of behavioural objectives before instruction and those not so exposed?

To answer research question three, Mean and Standard Deviation as well as mean differences of pretest and posttest HCPT scores of students in the experimental and control groups were computed and used. The result is shown in Table 4.5:

Table 4.5: Mean and Standard Deviation Statistics of Pretest and Posttest HCPT Scores for Students in Experimental and Control Group.

Variable	Group	N	Mean	SD	Mean Difference
Performance	Experimental	69	16.97	17.00	
					2.20
	Control	64	14.76	2.94	

Table 4.5 shows the outcome of the descriptive statistics on any difference in the academic performance of students exposed to knowledge of behavioural objectives of lessons before instruction and their counter parts who were not so exposed. Their mean performance scores are 16.97 and 14.76 respectively with a mean difference of 2.20 in favour of experimental group. This indicates some positive effect of knowledge of behavioral objectives before instruction compared to those who were not exposed to knowledge of behavioural objectives before instruction. Therefore, higher mean score of experimental group can be attributed to the treatment administered. To ascertain if the difference in the mean scores between experimental and control is statistically significant, the corresponding null hypothesis was tested using t-test statistical tool.

Null Hypothesis Three: There is no significant difference between the mean academic performance scores of chemistry students exposed to knowledge of behavioural objectives before instruction and those not so exposed.

The t-test statistic was used to determine if there was any significant difference in the academic performance mean scores of the experimental and control groups. A summary of t-test of the groups' Academic Performance scores is presented in Table 4.6.

Table 4.6: Summary of t-test Analysis of Academic Performance Mean Scores of Experimental and Control Groups.

Variable	Groups	N	Mean	Std difference	Mean	df	t-value	p	Remark
Performance	Experimental	69	16.97	2.66					
	Control	64	14.76	2.94	2.20	131	4.53	0.00	Sig

Significant at $P < 0.05$

Table 4.6 shows the outcome of the independent t-test analysis of the performance scores of students exposed to knowledge of behavioral objectives before instruction and their counterpart who were not so exposed. A p value of 0.000 obtained is found to be lower than the critical 0.05 alpha level of significance. Their performance mean scores are 16.97 and 14.76 for the experimental and control groups respectively with a t-value of 4.53 at $p = 0.00$. This shows that the difference of the mean scores of the experimental and control groups is statistically significant in favour of the experimental group. Thus, the stated null hypothesis, which states that there is no significant difference in the mean performance scores of chemistry students exposed to knowledge of behavioural objectives and those not so exposed, is hereby rejected.

Research Question Four: What is the difference between the mean retention scores of chemistry students exposed to knowledge of behavioural objectives before instruction and those not so exposed?

To answer research question four, Mean and Standard Deviation as well as mean differences of pretest and posttest HCPT scores of students in the experimental and control groups were computed and used. The result is shown in Table 4.7:

Table 4.7: Descriptive Statistic of Experimental and Control Group Retention Level.

Variable	Group	N	Mean	SD	Mean Difference
Retention	Experimental	69	15.86	3.53	2.77
	Control	64	13.09	3.71	

Table 4.7 shows the outcome of the descriptive statistics on difference in the retention level of students exposed to knowledge of behavioural objectives of lessons before instruction and their counter parts who were not so exposed. Their mean performance scores are 15.86 and 13.09 respectively with a mean difference of 2.77 in favour of experimental group. This indicates

some positive effect that knowledge of behavioural objectives before instruction tended to produce in the experimental group as compared to the control group who were not exposed to knowledge of behavioral objectives before instruction. Therefore the higher mean score of the experimental group is mostly likely due to the effect of the treatment administered. To find out how significant the difference was, the data were subjected to t-test statistic.

Null Hypothesis Four: There is no significant difference between the mean retention scores of chemistry students exposed to knowledge of behavioural objectives before instruction and those not so exposed.

The t-test statistics was used to determine if there was any significant difference in the mean scores of the experimental and control groups in their retention levels. A summary of t-test of the subjects' Academic Performance scores is presented in Table 4.8.

Table 4.8: Summary of t-test Analysis of Retention Level Mean Scores of Experimental and Control Groups.

Variable	Groups	N	Mean	Std difference	Mean	df	t-value	p	Remark
	Experimental	69	15.86	3.53					
Retention					2.77	131	4.42	0.01	Sig
	Control	64	13.09	3.71					

Significant at $P < 0.05$

Table 4.8 shows the outcome of the independent t-test statistics in the retention level of the experimental and the control groups. A p value of 0.01 obtained for the t-value of 4.42 was lower than the critical 0.05 alpha level of significance. This shows that the mean difference obtained for the two groups at t-value = 4.42 is statically significant at $P \leq 0.05$ in favour of the experimental group. Thus, the second null hypothesis (H_{O4}) is hereby rejected.

4.3 Summary of Findings

Based on the result of this study, the following findings were made.

1. There was significant difference in the Pretest and Posttest academic performance mean scores of students exposed to knowledge of behavioural objectives. This shows that knowledge of behavioural objectives enhances academic performance of students exposed to knowledge of behavioural objectives of the lesson.
2. There was no significant difference in the Pretest and Posttest academic performance mean scores of male and female students exposed to knowledge of behavioural objectives. This shows that gender does not influence academic performance when exposed to knowledge of behavioural objectives before instruction.
3. There was significant difference in the academic performance between students exposed to knowledge of behavioural compared to those who were not so exposed. Meaning that knowledge of behavioural objectives before instruction is effective compared to instruction without knowledge of behavioural objectives.
4. There was significant difference in the retention level of chemistry students exposed to knowledge of behavioural objectives compared to those who were not so exposed. This implies that knowledge of behavioural objectives before instruction in chemistry enhances retention level.

4.4 Discussion of the Findings

In Table 4.2 the result of testing Hypothesis 1 shows that there was significant difference in the Pretest and Posttest academic performance mean scores of chemistry students exposed to knowledge of behavioural objectives (experimental group). If the treatment administered has no positive effect; the two mean scores would not have been statistically significant. Since the Posttest score is significantly better than the pretest mean score, it implies that knowledge of

behavioural objectives to which they were exposed during the treatment improved the student's academic performance more than the period they were not so exposed. The result aligns with earlier findings of Oloyede (2006); Arokoyu (2006); Ugonwa (2007); and Asiyari (2009) who found that exposure to knowledge of behavioural objectives before instructions has the potential to enhance the quality of student academic performance. On the contrary, Keskin and Ergin (2012) have reported negative impacts of Knowledge of behavioural objectives before instructions on academic achievements of students in Turkey.

In Table 4.6 the result of testing Hypothesis 3 shows that there was significant difference in the mean academic performance scores of students exposed to knowledge of behavioural objectives before instruction compared to their counterparts who were not so exposed. This result is not entirely surprising, as in fact, confirms the assumption that students exposed to knowledge of behavioural objectives before instruction (experimental) performed significantly better than their counterpart who were not so exposed. This finding agrees with that of Ayogu, (2010) who found that knowledge of behavioural objectives before instructions has the potential of enhancing the academic performance of students so exposed. However, this finding contradicts those of Hiccan (2018) which indicated a negative impact of knowledge of behavioural objectives before instruction.

The result in Table 4.8 shows that there was significant difference in the retention level scores of the subjects exposed to knowledge of behavioural objectives (experimental group) compared to their counterpart (control group) who were not so exposed. This was confirmed by the observation that the difference in the retention level of the experimental and the control groups are statistically significant in favour of the experimental group, it implies that knowledge of behavioural objectives enhanced the student's retention level. This result tallies with earlier findings of scholars like Chukwuneka (2012); Duniya (2014); Abel (2014); Eniayeju (2015); and

Ibe (2016) who found that students exposed to knowledge of behavioural objectives performed significantly better in their retention level scores than their counter part who were not so exposed. On the contrary, Anil and Batdi (2018) have reported negatively in their findings of students exposed to knowledge of behavioural objectives performing significantly poor in their retention level scores than their counter who were not so exposed.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The aim of this study was to investigate the influence of Knowledge of Behavioural Objectives on Academic Performance and Retention of Secondary School Chemistry Students in Giwa education zone, Kaduna state, Nigeria. This chapter presents the summary of the study under the following subheadings:

5.2 Summary of the Study

5.3 Summary of Major Findings

5.4 Conclusion

5.5 Contributions to Knowledge

5.6 Recommendations

5.7 Limitation of the Study

5.8 Suggestion for Further Studies

5.2 Summary of the Study

This study investigated the influence of knowledge of behavioural objectives on academic performance and retention of secondary school chemistry students in Giwa Education Zone, Kaduna state, Nigeria. The study was structured into five chapters.

Chapter one dealt with the background of the study, problems that prompted the researcher to carry out the study, theoretical framework, significance of the study as well as the scope of the study. The objectives, research questions and hypotheses were also examined.

Chapter two consisted of the review of related literatures and was discussed under the following subheadings: historical perspective of science education in Nigeria, philosophy and objectives of

science education in Nigeria, teaching chemistry at senior secondary school level, the senior secondary school chemistry curriculum, students' academic performance in chemistry at senior secondary schools, retention of learnt concepts and academic performance in chemistry, concept of hydrocarbons, concept of behavioural objectives in science teaching, overview of similar studies, and implications of the literature reviewed on the present study.

Chapter three contains the research design which was pretest and posttest quasi-experimental and control group design. The population of the study comprised of all senior secondary II chemistry students of the fourteen (14) senior secondary schools in Giwa education zone, Kaduna state Nigeria. The total population of students in these schools was 667 comprising of 391 males and 276 females. Simple random sampling technique by balloting was used to select four (4) schools from the fourteen (14) public Senior Secondary Schools in the study area. The four schools selected were Government Secondary School Hunkuyi, Government Secondary School Basawa, Government Secondary School Giwa and Government Secondary School Shika (Snr). Pre-test was administered to SS2 Chemistry students in each of the four schools randomly selected to determine their equivalence in terms of academic performance. The results obtained from the schools were subjected to One-Way Analysis of Variance (ANOVA) and Scheffe's test. One-Way ANOVA was used to determine the existence of any significant difference in the four schools while the Scheffe's Post Hoc test was used to separate the schools and figure out which schools were significantly or not significantly different. Three schools (G.S.S. Basawa, G.S.S. Bomo and G.S.S. Hunkuyi) showed no significant difference out of which two schools were randomly picked using the method of draw-from the hat random selection for the study. The schools were G.S.S. Basawa and G.S.S. Bomo respectively. The sample size consisted of one hundred and thirty-three (133) students with the experimental group having a total of sixty-nine (69) students

and the control group having a total of sixty-four (64) students. The topics taught were based on hydrocarbon concept. A forty (40) item multiple choice questions tagged Hydrocarbon Concepts Performance Test (HCPT) was used to collect data and the data collected were analyzed using descriptive statistics and t-test statistical tool.

The statistical analysis and interpretation of the findings from the analyzed data was presented in chapter four. Table 4.1 presented the mean scores and t-test analysis of the Pretest and Posttest performance scores for the experimental group. Table 4.3 presented the mean scores and t-test analysis of male and female student's performance scores for the experimental group. Table 4.5 presented the mean scores and t-test analysis of performance scores for the experimental and control groups. Table 4.7 showed the mean scores and t-test analysis of retention level for the experimental and control groups. Detailed discussions of the results obtained were also captured in this chapter.

Chapter five focuses on the summary of the entire research work, summary of major findings, conclusions, recommendations, limitations, suggestions for further studies and contributions to knowledge.

5.3 Summary of Major Findings

The following constitute the summary of major findings:

1. There is a significant difference between the pretest and posttest scores of subjects exposed to knowledge of behavioural objectives in favour of their posttest scores. This indicates that knowledge of behavioural objectives is effective in enhancing student's academic performance if used efficiently.
2. There is no significant difference between the academic performance scores of male and female students exposed to knowledge of behavioural objectives before instruction. This

indicates that gender does not influence academic performance when exposed to knowledge of behavioural objectives before instruction.

3. The analysis of the performance posttest scores indicates that there is a significant difference in academic performance between the subjects exposed to prior knowledge of behavioural objectives and their counterpart who were not so exposed. This was in favour of the experimental group. That is, the experimental group performed significantly better than the control group in their academic performance after experimental treatment.

4. There is a significant difference between the retention levels of the subjects exposed to knowledge of behavioural objectives and their counterpart who were not so exposed in favour of the experimental group. Knowledge of behavioural objectives was found to be significantly effective in enhancing the retention level of chemistry students at the Senior Secondary School level.

5.4 Conclusion

Based on the results obtained from this study, the following conclusion can be made;

1. The experimental subjects performed better in their posttest scores than their pretest scores as a result of the treatment (knowledge of behavioural objectives) provided.
2. Gender does not influence academic performance of the experimental subjects when exposed to knowledge of behavioural objectives before instruction.
3. Knowledge of behavioural objectives was found to enhance academic performance of the experimental subjects before instruction as compared to the control subjects who were not so exposed before instruction.

4. Knowledge of behavioural objectives also enhanced the retention level of experimental subjects exposed to it.

5.5 Contributions to Knowledge

The result and findings of this study has made the following contribution to knowledge:

1. The findings of this study have established the potency of knowledge of behavioural objectives as a viable tool for enhancing academic performance among chemistry students.
2. The findings of this study have also added new information to the frontier of knowledge in the existing literature.
3. The researcher developed hydrocarbon concept performance test which could be used by other researchers in future. The lesson plan developed for the study can also be used by other researchers and teachers.

5.6 Recommendations

Based on the findings of this study, the following recommendations are made;

1. Science teachers should be encouraged to apply knowledge of behavioural objectives in their teaching-learning process as it was found from this study to enhance student academic performance.
2. Seminar/workshop should be organized by professional bodies like Science Teacher's Association of Nigeria (STAN) for all science teachers to enable them have the skills of effectively and efficiently applying knowledge of behavioural objectives in teaching – learning process.
3. Education policy makers should instruct authors of various textbooks used in secondary schools to include the specific behavioural objectives of each topic. This would go a long way in helping students focus on the important aspects of each lesson and the texts.

4. Chemistry teachers should make sure that behavioural objectives of lessons are stated in clear, unambiguous terms. It would help students understand what is expected of them at the end of each instruction.

5.7 Limitations of the Study

The following limitation was noted in the course of this study;

Poor communication skills in English on the part of some students was a problem as the researcher often had to use the help of one who speaks the native dialect (Hausa) to explain some concept to the study subject.

5.8 Suggestions for Further Studies

1. Similar studies could be carried out at tertiary institutions such as colleges of education, Polytechnics, Mono-technics and Universities.

2. This type of study would also be conducted in other science discipline such as Physics, Agricultural Science, Biology and Basic Science among Others.

3. It may be worthwhile investigating the effects of behavioural objectives on attitude of secondary school chemistry students.

4. Other researchers may wish to replicate this study by changing some variables like the subject used and the location of the study subjects. This will probably broaden the empirical base of these findings.

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APPENDIX A

HYDROCARBON CONCEPTS PERFORMANCE TEST (HCPT)

Dear respondent

Below are multiple-choice questions based on the knowledge of hydrocarbon. They are meant for a research study aimed at improving the teaching and learning of chemistry. You are requested to answer the questions based on your knowledge of hydrocarbons. The researcher hereby assured you that your answer script and responses will be kept under strict confidentiality and sincerity. To ensure the confidentiality of your answers and identity, you are not required to include your name.

SECTION A: BIO DATA

Name of School.....

Class.....

Age.....

Gender

MALE

FEMALE

SECTION B: General instructions

Please read the following instructions carefully before you begin to answer the questions.

1. Use HP pencil provided for answering the questions.
2. Write your school name, class and identification number in the spaces provided in the answer sheet.
3. After you have selected the correct answer, go to your answer and shade the corresponding letter only (a, b, c or d) in the space provided in the answering sheet.
5. Shade only one letter of your choice for each answer in the multiple choice questions.
6. If you change your mind on any answer, completely erase the first before entering the new one you chose.

HYDROCARBON CONCEPT PERFORMANCE TEST (HCPT)

Instruction: This test contains 40 multiple-choice questions you are required to fill in the correct answers in blank spaces provided in the answer sheet.

1. One of the chemical tests that can distinguish ethane from ethene is that?

- (a). ethane decolourize bromine water while ethene does not.
- (b). ethene decolourize bromine water while ethane does not.
- (c). ethane give white precipitate with ammonical solution while ethane does not.
- (d). none of the above.

2. Methane is a member of the homologous series called:

- (a). Alkenes
- (b). Alcohols
- (c). Alkanes
- (d). These compounds are not related at all, they are totally different.

3. The names of a homologous series depend on?

- (a). first member of the series
- (b). second member of the series families
- (c). member of alkyl group series
- (d). functional group.

4. Organic chemistry is defined as the study of the chemistry of:

- (a). hydrocarbon only.
- (b). hydrocarbon and its derivatives
- (c). carbon only.
- (d). carbon and its derivatives.

5. The IUPAC name of $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$ is?

- (a). But – 1 – ene
- (b). But – 4 – ene
- (c). But – 3 – ene

(d). But – 2 – ene

6. Which of the following is an alkene?

(a). $C_6H_5CH_3$

(b). $CH_3(CH_2)_4CH_3$

(c). $CH_2CH=CHCH_3$

(d). $CH_3CH_2CH_3$

7. Alkynes have the general formula given by:

(a). C_nH_{2n-2}

(b). C_nH_{2n+2}

(c). C_nH_{2n}

(d). C_nH_{2n+1}

8. Alkynes burns with luminous smoky flame because of:

(a). high carbon content

(b). low carbon content

(c). high hydrogen content

(d). low hydrogen content.

9. The alkanes are known as paraffin's because:

(a). They are hydrocarbons

(b). they consists of only single bonds

(c). they are saturated and liner in nature

(d). addition reaction

10. Which of the following is the IUPAC name of the organic compound $CH_3CH_2CHClCH_3$ is?

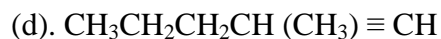
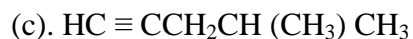
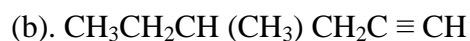
(a). 3 - chlorobutane

(b). butan -3- chlorine

(c). 1-chlorobutane

(d). 2-chlorobutane.

11. Structure of 4-methylhex-1-yne is?



12. Terminal alkynes give what precipitate with ammonia solutions of AgNO_3 ?

(a). reddish-brown

(b). black

(c). white

(d). dirty green

13. How many carbon atoms are there in benzene ring?

(a). 4

(b). 5

(c). 6

(d). 7

14. The hydrocarbon in which all the 4 valences of carbon are fully occupied is called:

(a). Alkene

(b). Alkyne

(c). Alkane

(d). Cycloalkane.

15. The simplest member of organic compound is:

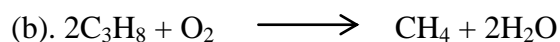
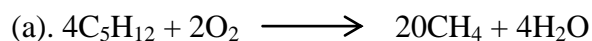
(a). Methanol

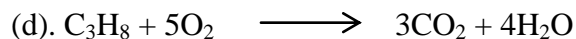
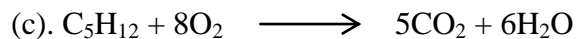
(b). Methane

(c). Formaldehyde

(d). Formic acid

16. The balanced equation for the combustion of pentane is:





17. The IUPAC name of $(CH_3)_3 CCH_2 (CH_2)_3 CH_3$ is?

(a). 1,1-dimethylheptane

(b). 3-methylheptane

(c). 2,2-dimethylheptane

(d). pentane

18. Hydrocarbons can be classified into?

(a). Aliphatic hydrocarbons only

(b). Aliphatic and Aromatic hydrocarbons.

(c). Aromatic hydrocarbons only.

(d). Cyclic hydrocarbons only.

19. The process of linking together small alkyne molecules to form a chain of repeating unit is referred to as:

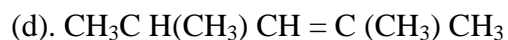
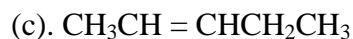
(a). cracking

(b). isomerization

(c). polymerization

(d). aromatization

20. The structural formula of 2, 4 – dimethylpent-2-ene is?



21. The following are natural sources of alkanes except:

(a). plant

(b). fungi and microorganism

(c). minerals

(d). synthetic reactions.

22. Ethene molecules can be added to one another repeatedly to form a long chain compound called?

- (a). polymer
- (b). dimer
- (c). monomer
- (d). trimer

23. Find the odd one out:

- (a). Aromatic
- (b). Alkanes
- (c). Alkynes
- (d). Alkenes

24. Which of the following is a saturated hydrocarbon?

- (a). C_2H_6
- (b). C_2H_4
- (c). C_2H_2
- (d). C_3H_6

25. The general molecular formula of alkenes is?

- (a). C_nH_{2n-2}
- (b). C_nH_{2n+2}
- (c). C_nH_{2n-1}
- (d). C_nH_{2n}

26. Hydrocarbons are compounds containing which of the following?

- (a). carbon and nitrogen only.
- (b). carbon only.
- (c). carbon, hydrogen and oxygen.
- (d). carbon and hydrogen only.

27. The process involved in converting ethyne to ethane is known as:

- (a). hydrogenation

(b). dehydrogenation

(c). hydration

(d). isomerization

28. Unsaturation in hydrocarbons is found in?

(a). ethane

(b). 2-methylpropane

(c). 2, 2, 4-trimethylpentane

(d). butyne

29. Which of the following statements is true about alkane?

(a). The density of normal alkane decreases with increase in the number of carbon atom.

(b). Branch alkanes boil at higher temperature than normal alkane with the same number of carbon atoms.

(c). The melting point, boiling point and the density of normal alkane increases with increase in the number carbon atom.

(d). All of the above.

30. The followings are hydrocarbons except?

(a). methyl propanol

(b). methylbenzene

(c). benzene

(d). cyclohexane

31. When ethanol is heated with excess concentrated tetraoxosulphate (vi) acid, the organic product formed is?

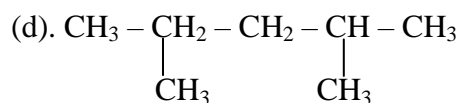
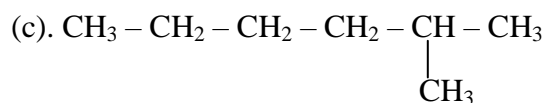
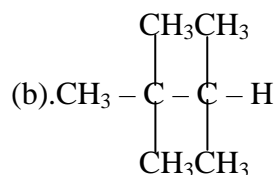
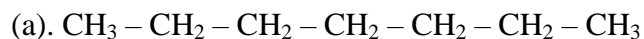
(a). ethane

(b). ethene

(c). ethyne

(d). butyne

32. Which of the following alkanes would have the highest boiling point?



33. Catenation is the ability of carbon atoms to:

(a). combine with one another to form straight chains, branched chains or ring compounds containing many carbon atoms.

(b). combine with hydrogen, oxygen, nitrogen and halogens.

(c). form single, double or triple covalent bonds.

(d). combine with every element.

34. ___ is an atom, or group of atoms, a radical or a bond common to a homologous series, and which determines the chemical properties of the series?

(a). functional group

(b). functional series

(c). reaction series

(d). group.

35. In a reaction between $\text{CH}_3 - \text{CH} = \text{CH}_2$ and HBr. Which of the carbon atoms will the Br attach to?

(a). CH

(b). CH_2

(c). CH_3

(d). none of the above.

36. A family of organic compounds which follows a regular pattern, in which each successive member differs in its molecular formula by a $-\text{CH}_2-$ group is known as

- (a). functional group?
- (b). aromatic hydrocarbons
- (c). aliphatic aromatic
- (d). homologous series

37. Alkynes are regarded as unsaturated hydrocarbons because of the?

- (a). Presence of long chain structure
- (b). Presence of triple bond in its structure
- (c). Absence of pi electron in its structure
- (d). Presence of hydrogen atoms in its structure.

38. If the first member of a homologous is C_2H_4 , then the next member will be?

- (a). C_2H_4
- (b). C_2H_8
- (c). C_3H_6
- (d). C_3H_8

39. Ethyne gives reddish-brown precipitates with ammonical solution of copper (I) chloride while but-2-yne does not because but-2-yne is a/an:

- (a). terminal alkyne
- (b). internal symmetrical alkyne
- (c). unsymmetrical alkyne
- (d). all of the above.

40. The two main types of Isomerism are:

- (a). Structural and non-structural
- (b). Structural and Stereoisomerism
- (c). Cis and Trans
- (d). Geometric and non-geometric.

APPENDIX B

MARKING SCHEME FOR HYDROCARBON CONCEPTS PERFORMANCE TEST (HCPT)

Question

1B	21D
2C	22A
3D	23A
4B	24A
5A	25D
6C	26D
7A	27A
8A	28D
9C	29C
10D	30A
11C	31B
12C	32D
13C	33A
14C	34A
15B	35A
16C	36D
17C	37B
18B	38C
19C	39B
20D	40B

APPENDIX C

HYDROCARBON CONCEPTS PERFORMANCE TEST (HCPT) ANSWER SHEET

SECTION A: BIO DATA

Name of School

Class.....

Gender Male Female

Age.....

Research Identification Number.....

SECTION B

Please shade the correct answer appropriately

- | | |
|---------------------------|-----------------------------|
| 1. =A= =B= =C= =D= | 21. =A= =B= =C= =D= |
| 2. =A= =B= =C= =D= | 22. =A= =B= =C= =D= |
| 3. =A= =B= =C= =D= | 23. =A= =B= =C= =D= |
| 4. =A= =B= =C= =D= | 24. =A= =B= =C= =D= |
| 5. =A= =B= =C= =D= | 25. =A= =B= =C= =D= |
| 6. =A= =B= =C= =D= | 26. =A= =B= =C= =D= |
| 7. =A= =B= =C= =D= | 27. =A= =B= =C= =D= |
| 8. =A= =B= =C= =D= | 28. =A= =B= =C= =D= |
| 9. =A= =B= =C= =D= | 29. =A= =B= =C= =D= |
| 10. =A= =B= =C= =D= | 30. =A= =B= =C= =D= |
| 11. =A= =B= =C= =D= | 31. =A= =B= =C= =D= |
| 12. =A= =B= =C= =D= | 32. =A= =B= =C= =D= |
| 13. =A= =B= =C= =D= | 33. =A= =B= =C= =D= |
| 14. =A= =B= =C= =D= | 34. =A= =B= =C= =D= |
| 15. =A= =B= =C= =D= | 35. =A= =B= =C= =D= |
| 16. =A= =B= =C= =D= | 36. =A= =B= =C= =D= |
| 17. =A= =B= =C= =D= | 37. =A= =B= =C= =D= |
| 18. =A= =B= =C= =D= | 38. =A= =B= =C= =D= |
| 19. =A= =B= =C= =D= | 39. =A= =B= =C= =D= |
| 20. =A= =B= =C= =D= | 40. =A= =B= =C= =D= |

APPENDIX D

LESSON PLAN FOR EXPERIMENTAL GROUP.

FIRST WEEK.

SUBJECT: Chemistry

CLASS: SSII

Average Age: 16 Years

DURATION: 40 minutes

TOPIC: Hydrocarbon

Instructional materials: Chalk and board.

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

- i. define hydrocarbon.
- ii. enumerate and briefly explain the two classes of hydrocarbon.
- iii. mention four sources of hydrocarbon.
- iv. state any four uses of hydrocarbon.

Previous Knowledge: The students have learnt about carbon and its compounds.

Presentation

Step i. The teacher begins his lesson asking the students some questions based on their previous knowledge of carbon and its compounds.

Step ii. The teacher introduce the new topic i.e. Hydrocarbon and write the behavioural objectives of the lesson on the chalk board.

At the end of the lesson, you should be able to:

- i. define hydrocarbon.

ii. enumerate and briefly explain the two classes of hydrocarbon.

iii. mention four sources of hydrocarbon.

iv. state any four uses of hydrocarbon.

Step iii. The teacher defines Hydrocarbons organic compounds composed only of two elements – carbon and hydrogen – their name. The main source of hydrocarbon is crude oil. The two main classes of hydrocarbons are – aliphatic and aromatic hydrocarbons.

Aliphatic hydrocarbons are composed of carbon chains of which the carbon chains are straight or branched.

Aromatic hydrocarbons are all cyclic compounds i.e. the end carbon atoms chain join together to form a ring.

Step iv. The teacher explains the concept of crude oil which is the main source of hydrocarbons and its origin.

Step v. The teacher explains fractional distillation of crude oil, fractions of crude oil such as petroleum gas, petrol, kerosene etc. and uses of crude oil.

Summary: The teacher summarizes the lesson by briefly going through the main points of the lesson.

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

i. What is hydrocarbon?

ii. Briefly explain the two classes of hydrocarbon

iii. Mention any four properties of hydrocarbon

iv. State any four sources of hydrocarbon.

v. Mention four uses of hydrocarbon

Conclusion: The teacher concludes the lesson by asking students to read about functional group and homologous series. s

Assignment: The teacher gives the students the following assignment.

i. With the aid of a diagram, briefly describe the industrial fractionation of petroleum.

WEEK TWO

SUBJECT: Chemistry

CLASS: SSII

Average Age: 16 Years

Model of Teaching: Lecture Method

DURATION: 40 minutes

TOPIC: Functional group.

Instructional materials:Chalk and board.

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

- i. define Functional group.
- ii. identify the functional group in a given compound.
- iii. define homologous series and give relevant examples.
- iv. mention the characteristics of homologous series.

Previous Knowledge: The students have studied and known petroleum and its products.

Presentation

Step i. The teacher begins his lesson by asking the students some questions based on their previous knowledge of petroleum and its products.

Step ii. The teacher introduces the lesson functional group and presents the behavioural objectives of the lesson as follows.

At the end of the lesson, you should be able to:

- i. define Functional group.
- ii. identify the functional group in a given compound.

iii. define homologous series and give relevant examples.

iv. mention the characteristics of homologous series.

Step iii. The teacher defines functional group. Functional group is an atom, a radical (group of atoms) or a bond common to a homologous series, and which determines the main chemical properties of the series. E.g. the hydroxyl group -OH , the amino group, -NH_2 , the carboxyl group, -COOH etc.

Homologous series. Homologous series is a family of organic compounds which follows a regular structural pattern, in which each successive member differs in its molecular formula by a $\text{-CH}_2\text{-}$ group.

Step iv. The teacher mentions the characteristics of homologous series such as general molecular formula, difference between successive homologues etc.

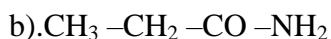
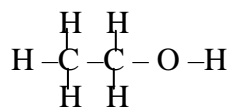
Summary: The teacher summarizes the lesson by briefly going through the main points of the lesson.

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

i. Briefly explain the meaning of homologous series.

ii. State any four characteristics of homologous series

iii. Identify the functional group in the following compounds



iv. What is the general formula of the following?

a). Alkanes b). Alkenes c). Alkynes d). Alcohols.

Conclusion: The teacher concludes the lesson by asking students to read about Alkane group.

Assignment: The teacher gives the students the following assignments.

1. Write briefly on the following

(a). Homologous series (b). Functional group

2. What is the general formula of Alkanols?

WEEK THREE

SUBJECT: Chemistry

CLASS: SSII

Average Age: 16 Years

Model of Teaching: Lecture Method

DURATION: 40 minutes

TOPIC: Alkanes

Instructional materials:Chalk and board.

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

- i. briefly explain the meaning of alkane and mention the first ten members.
- ii. name certain alkane compounds.
- iii. mention the physical and chemical properties of alkanes
- iv. mention the uses of alkanes

Previous Knowledge: The students have studied and known petroleum and its products.

Presentation

Step i. The teacher begins his lesson asking the student some questions based on their previous knowledge of functional group and homologous series.

Step ii. The teacher introduces the lesson alkane and presents the behavioural objectives of the lesson as follows.

At the end of the lesson, you should be able to:

- i. briefly explain the meaning of alkane and mention the first ten members.
- ii. name certain alkane compounds.

iii. mention the physical and chemical properties of alkanes

iv. mention the uses of alkanes

Step iii. The teacher explains the meaning of alkane and mentions the first ten members.

Alkanes are aliphatic hydrocarbons. They form a homologous series of saturated hydrocarbons, which can be represented by the general molecular formula, C_nH_{2n+2} . Members of the alkane group are methane, ethane, propane, pentane etc. The teacher gives other examples of alkane compound structure and their names.

Step iv. The teacher explains the physical and chemical properties of the alkane group.

Step v. The teacher mentions the uses of alkanes such as fuel, an anesthetic used in surgical operations etc.

Summary: The teacher summarizes the lesson by briefly going through the main points of the lesson.

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

i. What are alkanes?

ii. Mention any two physical properties and two chemical properties of alkanes

iii. Mention any four uses of alkanes

iv. Name the following alkane compounds.

(a). $CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3$

(b). $CH_3-CH_2-CH_2-CH_2-\underset{\begin{array}{c} | \\ CH_3 \end{array}}{CH_2}-CH_2-CH_3$

(c). $CH_3-\underset{\begin{array}{c} | \\ CH_3 \end{array}}{CH}-CH_2-\underset{\begin{array}{c} | \\ CH_3 \end{array}}{CH}-CH_3$

Conclusion: The teacher conclude the lesson by asking students to read about

Assignment: The teacher gives the students the following assignments.

1. What are alkenes?

2. Mention two physical and two chemical properties of alkenes.

WEEK FOUR

SUBJECT: Chemistry

CLASS: SSII

Average Age: 16 Years

Model of Teaching: Lecture Method

DURATION: 40 minutes

TOPIC: Alkenes

Instructional materials: Chalk and board.

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

- i. briefly explain the meaning of alkene and mention the first ten members of the alkene group.
- ii. name the following alkene compound
 - (a). $\text{CH}_3\text{C}(\text{CH}_3)\text{CH}_2\text{C}(\text{CH}_3)=\text{CH}_2$
 - (b). $(\text{CH}_3)_3\text{CCH}=\text{CHCH}_3$
 - (c). $\text{CH}_3\text{CH}=\text{CHCH}_2\text{CH}_3$
 - (d). $\text{CH}_3\text{C}(\text{CH}_3)\text{CH}=\text{C}(\text{CH}_3)\text{CH}_3$
- iii. mention four physical properties of the alkene group.
- iv. mention four chemical properties of the alkene group.
- v. state any four uses of alkenes.

Previous Knowledge: The students have studied and known alkane group and examples of alkane members.

Presentation

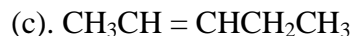
Step i. The teacher begins his lesson asking the student some questions based on their previous knowledge of the alkane group.

Step ii. The teacher introduces the lesson functional group and presents the behavioural objectives of the lesson as follows.

At the end of the lesson, you should be able to:

i. briefly explain the meaning of alkene and mention the first ten members of the alkene group.

ii. name the following alkene compound



iii. mention four physical properties of the alkene group.

iv. mention four chemical properties of the alkene group.

v. state any four uses of alkenes.

Step iii. The teacher explains the meaning of alkene and mentions the first ten members.

Alkenes are a homologous series of hydrocarbons with a general molecular formula of C_nH_{2n} , where n is a positive whole number which is equal to or greater than 2 (CH_2 does not exist). Members of the alkene group are ethene, propene, pentene etc. The teacher gives examples of alkene compound structure and their names.

Step iv. The teacher explains the physical and chemical properties of the alkene group.

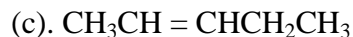
Step v. The teacher mentions the uses of alkenes such as Ethene which is the raw material used for making many important plastics etc.

Summary: The teacher summarizes the lesson by briefly going through the main points of the lesson.

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

i. What are alkenes?

ii. Name the following alkenes compound



iii. Mention any four physical properties of alkenes

iv. Mention any four chemical properties of alkenes

v. Mention any four uses of alkenes

Conclusion: The teacher conclude the lesson by asking students to read about

Assignment: The teacher gives the students the following assignments.

1. Give two examples of liquid alkanes together with their formulae.

WEEK FIVE.

SUBJECT: Chemistry

CLASS: SSII

Average Age: 16 Years

Model of Teaching: Lecture Method

DURATION: 40 minutes

TOPIC: Alkynes

Instructional materials: Chalk and board.

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

- i. briefly explain the meaning of alkynes and mention the first ten members of the alkyne group.
- ii. name the following alkyne compound
 - (a). $\text{CH}_3\text{CH}_2\text{CH}_3\text{CH}(\text{CH}_3)\text{C}\equiv\text{CH}$ (b). $\text{HC}\equiv\text{CCH}_2\text{CH}(\text{CH}_3)\text{CH}_3$
 - (b). $\text{CH}_3\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{C}\equiv\text{CH}$ (d). $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{C}\equiv\text{CH}$
- iii. mention four physical properties of alkynes
- iv. enumerate any four chemical properties of alkynes
- v. state any four uses of alkyne.

Previous Knowledge: The students have studied and known petroleum and its products.

Presentation

Step i. The teacher begins his lesson asking the student some questions based on their previous knowledge of petroleum and its products.

Step ii. The teacher introduces the lesson functional group and presents the behavioural objectives of the lesson as follows.

At the end of the lesson, you should be able to:

i. briefly explain the meaning of alkynes and mention the first ten members of the alkyne group.

ii. name the following alkyne compound

(a). $\text{CH}_3\text{CH}_2\text{CH}_3\text{CH}(\text{CH}_3)\text{C}\equiv\text{CH}$ (b). $\text{HC}\equiv\text{CCH}_2\text{CH}(\text{CH}_3)\text{CH}_3$

(b). $\text{CH}_3\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{C}\equiv\text{CH}$ (d). $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{C}\equiv\text{CH}$

iii. mention four physical properties of alkynes

iv. enumerate any four chemical properties of alkynes

v. state any four uses of alkyne.

Step iii. The teacher explains the meaning of alkyne and mentions the first ten members.

Alkynes are the homologous series of unsaturated hydrocarbons, which can be represented by the general molecular formula, $\text{C}_n\text{H}_{2n-2}$. Where n is a positive whole number which is equal to or greater than 2. Members of the alkyne group are ethyne (C_2H_2), propyne (C_3H_4), pentyne (C_4H_6) etc. The teacher gives examples of alkyne structures and their names.

Step iv. The teacher explains the physical and chemical properties of the alkyne group.

Step v. The teacher mentions the uses of alkynes such as fuel in lamps etc.

Summary: The teacher summarizes the lesson by briefly going through the main points of the lesson.

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

i. What are alkynes?

ii. Name the following alkynes compound.

(a). $\text{CH}_3\text{CH}_2\text{CH}_3\text{CH}(\text{CH}_3)\text{C}\equiv\text{CH}$ (b). $\text{HC}\equiv\text{CCH}_2\text{CH}(\text{CH}_3)\text{CH}_3$

(b). $\text{CH}_3\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{C}\equiv\text{CH}$ (d). $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{C}\equiv\text{CH}$

iii. Mention any four physical properties of alkynes

iv. Mention any four chemical properties of alkynes

v. Mention any four uses of alkynes

Conclusion: The teacher conclude the lesson by asking students to read about

Assignment: The teacher gives the students the following assignments.

1. How would you prepare ethyne in the laboratory?

2. Give three industrial uses of alkanols.

APPENDIX E

LESSON PLAN FOR CONTROL GROUP.

FIRST WEEK.

SUBJECT: Chemistry

CLASS: SSII

Average Age: 16 Years

Model of Teaching: Lecture Method

DURATION: 40 minutes

TOPIC: Hydrocarbons

Instructional materials: Chalk and board.

Note: The stated behavioural objectives for each lesson are the same for both the experimental and the control group. However, because of the nature of the study, prior statements of the behavioural objectives are withheld for the control group.

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

- i. define hydrocarbon.
- ii. enumerate and briefly explain the two classes of hydrocarbon.
- iii. mention four sources of hydrocarbon.
- iv. state any four uses of hydrocarbon.

Previous Knowledge: The students have learnt about carbon and its compounds.

Presentation

Step i. The teacher begins his lesson asking the students some questions based on their previous knowledge of carbon and its compounds.

Step ii. The teacher introduces his lesson by defining hydrocarbons. Hydrocarbons are organic compounds composed only of two elements – carbon and hydrogen – their name. The main source of hydrocarbon is crude oil.

Step iii. The teacher explains the two main classes of hydrocarbons – aliphatic and aromatic hydrocarbons.

Aliphatic hydrocarbons are composed of carbon chains of which the carbon chains are straight or branched.

Aromatic hydrocarbons are all cyclic compounds i.e. the end carbon atoms chain join together to form a ring.

Step iv. The teacher explains the concept of crude oil which is the main source of hydrocarbons and its origin.

Step v. The teacher explains fractional distillation of crude oil, fractions of crude oil such as petroleum gas, petrol, kerosene etc. and uses of crude oil.

Summary: The teacher summarizes the lesson by briefly going through the main points of the lesson.

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

- i. What is hydrocarbon?
- ii. Briefly explain the two classes of hydrocarbon
- iii. Mention any four properties of hydrocarbon
- iv. State any four sources of hydrocarbon.
- v. Mention four uses of hydrocarbon

Conclusion: The teacher concludes the lesson by asking students to read about functional group and homologous series.

Assignment: The teacher gives the students the following assignment.

i. With the aid of a diagram, briefly describe the industrial fractionation of petroleum.

WEEK TWO

SUBJECT: Chemistry

CLASS: SSII

Average Age: 16 Years

Model of Teaching: Lecture Method

DURATION: 40 minutes

TOPIC: Functional group.

Instructional materials: Chalk and board.

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

- i. define Functional group.
- ii. identify the functional group in a given compound.
- iii. define homologous series and give relevant examples.
- iv. mention the characteristics of homologous series.

Previous Knowledge: The students have studied and known petroleum and its products.

Presentation

Step i. The teacher begins his lesson by asking the students some questions based on their previous knowledge of petroleum and its products.

Step ii. The teacher defines functional group. Functional group is an atom, a radical (group of atoms) or a bond common to a homologous series, and which determines the main chemical properties of the series. E.g. the hydroxyl group -OH , the amino group, -NH_2 , the carboxyl group, -COOH etc.

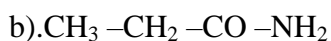
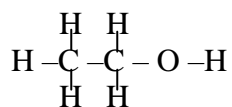
Step iii. The teacher defines homologous series. Homologous series is a family of organic compounds which follows a regular structural pattern, in which each successive member differs in its molecular formula by a $-\text{CH}_2-$ group.

Step iv. The teacher mentions the characteristics of homologous series such as general molecular formula, difference between successive homologues etc.

Summary: The teacher summarizes the lesson by briefly going through the main points of the lesson.

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

- i. Briefly explain the meaning of homologous series.
- ii. State any four characteristics of homologous series
- iii. Identify the functional group in the following compounds



- iv. What is the general formula of the following?
a). Alkanes b). Alkenes c). Alkynes d). Alcohols.

Conclusion: The teacher concludes the lesson by asking students to read about Alkane group.

Assignment: The teacher gives the students the following assignments.

1. Write briefly on the following
(a). Homologous series (b). Functional group
2. What is the general formula of Alkanols?

WEEK THREE

SUBJECT: Chemistry

CLASS: SSII

Average Age: 16 Years

Model of Teaching: Lecture Method

DURATION: 40 minutes

TOPIC: Alkanes

Instructional materials:Chalk and board.

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

- i. briefly explain the meaning of alkane and mention the first ten members.
- ii. name certain alkane compounds.
- iii. mention the physical and chemical properties of alkanes
- iv. mention the uses of alkanes

Previous Knowledge: The students have studied and known petroleum and its products.

Presentation

Step i. The teacher begins his lesson asking the student some questions based on their previous knowledge of functional group and homologous series.

Step ii. The teacher explains the meaning of alkane and mentions the first ten members.

Alkanes are aliphatic hydrocarbons. They form a homologous series of saturated hydrocarbons, which can be represented by the general molecular formula, C_nH_{2n+2} . Members of the alkane group are methane, ethane, propane, pentane etc.

Step iii. The teacher gives examples of alkane compound structure and their names.

Step iv. The teacher explains the physical and chemical properties of the alkane group.

Step v. The teacher mentions the uses of alkanes such as fuel, an anesthetic used in surgical operations etc.

Summary: The teacher summarizes the lesson by briefly going through the main points of the lesson.

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

i. What are alkanes?

ii. Mention any two physical properties and two chemical properties of alkanes

iii. Mention any four uses of alkanes

iv. Name the following alkane compounds.

(a). $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_3$

(b). $\begin{array}{cccccccc} \text{CH}_3 & \text{-CH}_2 & \text{-CH}_2 & \text{-CH}_2 & \text{-CH}_2 & \text{-CH}_2 & \text{-CH}_3 \\ & & & & | & & \\ & & & & \text{CH}_3 & & \end{array}$

(c). $\begin{array}{ccccccc} \text{CH}_3 & \text{-CH} & \text{-CH}_2 & \text{-CH} & \text{-CH}_3 \\ & | & & | & \\ & \text{CH}_3 & & \text{CH}_3 & \end{array}$

Conclusion: The teacher conclude the lesson by asking students to read about

Assignment: The teacher gives the students the following assignments.

1. What are alkenes?

2. Mention two physical and two chemical properties of alkenes.

WEEK FOUR

SUBJECT: Chemistry

CLASS: SSII

Average Age: 16 Years

Model of Teaching: Lecture Method

DURATION: 40 minutes

TOPIC: Alkenes

Instructional materials:Chalk and board.

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

- i. briefly explain the meaning of alkene and mention the first ten members of the alkene group.
- ii. name the following alkene compound
 - (a). $\text{CH}_3\text{C}(\text{CH}_3)\text{CH}_2\text{C}(\text{CH}_3)=\text{CH}_2$
 - (b). $(\text{CH}_3)_3\text{CCH}=\text{CHCH}_3$
 - (c). $\text{CH}_3\text{CH}=\text{CHCH}_2\text{CH}_3$
 - (d). $\text{CH}_3\text{C}(\text{CH}_3)\text{CH}=\text{C}(\text{CH}_3)\text{CH}_3$
- iii. mention four physical properties of the alkene group.
- iv. mention four chemical properties of the alkene group.
- v. state any four uses of alkenes.

Previous Knowledge: The students have studied and known alkane group.

Presentation

Step i. The teacher begins his lesson asking the student some questions based on their previous knowledge of the alkane group.

Step ii. The teacher explains the meaning of alkene and mentions the first ten members.

Alkenes are a homologous series of hydrocarbons with a general molecular formula of C_nH_{2n} , where n is a positive whole number which is equal to or greater than 2 (CH_2 does not exist). Members of the alkene group are ethene, propene, pentene etc.

Step iii. The teacher gives examples of alkene compound structure and their names.

Step iv. The teacher explains the physical and chemical properties of the alkene group.

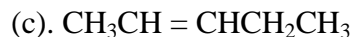
Step v. The teacher mentions the uses of alkenes such as Ethene which is the raw material used for making many important plastics etc.

Summary: The teacher summarizes the lesson by briefly going through the main points of the lesson.

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

i. What are alkenes?

ii. Name the following alkenes compound



iii. Mention any four physical properties of alkenes

iv. Mention any four chemical properties of alkenes

v. Mention any four uses of alkenes

Conclusion: The teacher conclude the lesson by asking students to read about

Assignment: The teacher gives the students the following assignments.

1. Give two examples of liquid alkanes together with their formulae.

WEEK FIVE

SUBJECT: Chemistry

CLASS: SSII

Average Age: 16 Years

Model of Teaching: Lecture Method

DURATION: 40 minutes

TOPIC: Alkynes

Instructional materials:Chalk and board.

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

- i. briefly explain the meaning of alkynes and mention the first ten members of the alkyne group.
- ii. name the following alkyne compound
 - (a). $\text{CH}_3\text{CH}_2\text{CH}_3\text{CH}(\text{CH}_3)\text{C}\text{CH}$
 - (b). $\text{HC}\text{CCH}_2\text{CH}(\text{CH}_3)\text{CH}_3$
 - (b). $\text{CH}_3\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{C}\text{CH}$
 - (d). $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{C}\text{CH}$
- iii. mention four physical properties of alkynes
- iv. enumerate any four chemical properties of alkynes
- v. state any four uses of alkyne.

Previous Knowledge: The students have studied and known petroleum and its products.

Presentation

Step i. The teacher begins his lesson asking the student some questions based on their previous knowledge of petroleum and its products.

Step ii. The teacher explains the meaning of alkyne and mentions the first ten members.

Alkynes are the homologous series of unsaturated hydrocarbons, which can be represented by the general molecular formula, C_nH_{2n-2} . Where n is a positive whole number which is equal to or greater than 2. Members of the alkyne group are ethyne (C_2H_2), propyne (C_3H_4), pentyne (C_4H_6) etc.

Step iii. The teacher gives examples of alkyne structures and their names.

Step iv. The teacher explains the physical and chemical properties of the alkyne group.

Step v. The teacher mentions the uses of alkynes such as fuel in lamps etc.

Summary: The teacher summarizes the lesson by briefly going through the main points of the lesson.

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

i. What are alkynes?

ii. Name the following alkynes compound.

(a). $CH_3CH_2CH_3CH(CH_3)C \equiv CH$ (b). $HC \equiv CCH_2CH(CH_3)CH_3$

(b). $CH_3CH_3CH(CH_3)CH_2C \equiv CH$ (d). $CH_3CH_2CH_2CH(CH_3)CH_2C \equiv CH$

iii. Mention any four physical properties of alkynes

iv. Mention any four chemical properties of alkynes

v. Mention any four uses of alkynes

Conclusion: The teacher conclude the lesson by asking students to read about

Assignment: The teacher gives the students the following assignments.

1. How would you prepare ethyne in the laboratory?

2. Give three industrial uses of alkanols.

APPENDIX F

Item Analysis for Hydrocarbon Concept Performance Test (HCPT).

Table for Facility and Discrimination Indices.

Item	$F.I. = \frac{R}{T}$	$D.I = \frac{RU - RL}{1/2 N}$
1	0.45	0.49
2	0.50	0.49
3	0.49	0.50
4	0.57	0.54
5	0.40	0.43
6	0.50	0.53
7	0.49	0.47
8	0.62	0.57
9	0.61	0.58
10	0.48	0.46
11	0.55	0.51
12	0.51	0.53
13	0.31	0.28
14	0.50	0.48
15	0.43	0.41
16	0.44	0.46
17	0.33	0.20
18	0.38	0.40
19	0.54	0.56
20	0.44	0.42
21	0.38	0.58
22	0.38	0.40
23	0.44	0.50
24	0.38	0.57
25	0.36	0.50
26	0.33	0.48
27	0.41	0.49
28	0.41	0.45
29	0.36	0.55
30	0.45	0.48

APPENDIX G

Frequencies

		Group			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Experimental	69	51.9	51.9	51.9
	Control	64	48.1	48.1	100.0
	Total	133	100.0	100.0	

APPENDIX H

t-test Statistic of Experimental and Control Group Academic Performance

Group Statistics					
	group	N	Mean	Std. Deviation	Std. Error Mean
performance	Experimental	69	16.9710	2.66221	.32049
	Control	64	14.7656	2.94792	.36849

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
performance	Equal variances assumed	.946	.333	4.533	131	.000	2.20539	.48649	1.24300	3.16778
	Equal variances not assumed			4.516	127.023	.000	2.20539	.48837	1.23900	3.17177

```
T-TEST GROUPS=group(1 2)
/MISSING=ANALYSIS
/VARIABLES=retention
/CRITERIA=CI(.95).
```

APPENDIX I

t-test Statistic of Experimental and Control Group Retention Level.

Group Statistics

	group	N	Mean	Std. Deviation	Std. Error Mean
retention	Experimental	69	15.8696	3.53933	.42609
	Control	64	13.0938	3.71064	.46383

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
retention	Equal variances assumed	1.915	.169	4.415	131	.000	2.77582	.62870	1.53209	4.01954
	Equal variances not assumed			4.407	129.050	.000	2.77582	.62983	1.52968	4.02195

APPENDIX J

t-test Statistics of Pretest and Posttest Mean Performance Scores of Experimental Group.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Posttest	16.9710	69	2.66221	.32049
	Pretest	14.7246	69	3.98853	.48016

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Posttest & Pretest	69	.049	.689

Paired Samples Test

		Paired Differences					t	Df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Posttest - Pretest	2.24638	4.68541	.56406	1.12082	3.37194	3.983	68	.002

