EFFECTS OF JIGSAW IV COOPERATIVE LEARNING STRATEGY ON STUDENTS' PERCEPTION, RETENTION AND PERFORMANCE IN ORGANIC CHEMISTRY IN ZARIA, KADUNA STATE, NIGERIA

BY

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CHAPTER ONE

THE PROBLEM

1.1 Introduction

The relevance of science to national goals, aspirations and economy dictates to a large extent, the huge commitment and support which nations make and give to science and technology advancement. 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 therefore cannot be over looked. The classification of any nation into developed, developing and underdeveloped could be measured accurately by the number of chemists, physicists, engineers, pharmacists, doctors, agriculture and science educators the nation could produce (Agogo, 2009, Maduawesi, Aboho & Okwuedei, 2010).

In Nigeria, the three major sciences, Biology, Chemistry and Physics are taught at the senior secondary school level. These major science subjects equip the young secondary school graduates with skills, attitudes, knowledge as pre-requisites abilities to function effectively in their future carriers at the tertiary level. According to the National Policy on Education (FRN, 2013) Chemistry Education should be emphasized at the secondary school in terms of its teaching and learning. This is because; chemistry as an academic discipline plays a very significant role in unifying other science subjects. Chemistry as an aspect of science studies the composition, properties and uses of matter (Ababio, 2007). Okeke and Ezekannagba (2000) also defined chemistry as a branch of science that deals with composition and changes of matter. Chemistry could therefore be seen as the science

and composition of matter and the changes in which matter undergoes. It probes into the changes that matter undergoes under different conditions.

Chemistry is everywhere; Chemistry is life; because it investigates the world around us and has contributed greatly towards providing us with basic needs of life such as food, clothing materials, housing materials, drugs, transportation, fertilizers, insecticides, and so on (Oloyede, 2010; Opara & Waswa, 2013; Ababio, 2007). Despite the key role of Chemistry as the central science that forms the basic foundation to many disciplines and in improving the quality of life, the performance of Nigeria secondary school students in the subject has for many years remained a matter of a serious concern (Jegede, 2010; Oloyede, 2010).

In addition, a study revealed that there is consistent decline in the performance of students in public examinations conducted by the West African Examination Council (WAEC) and the National Examination Council (NECO) in sciences across the country over the years (Samba & Eriba, 2012). WAEC also confirmed this decline in performance in Chemistry by WAEC Chief Examiner's Reports (2013, 2014, 2015, 2016 & 2017). This poor performance of students in Chemistry is due to some multifaceted factors. According to Usman (2010) and Abdullahi (2015), the factors that negatively affect Chemistry performance include students' lack of interest, poor study habit and teacher-related factors, like teachers' poor preparation, inadequately qualified Chemistry teachers and application of poor teaching methods. This situation has spurred research in Science Education and Educational Psychology to investigate the ways in which science students would learn science through meaningful interaction in a rich classroom environment.

Several teaching strategies have been advocated for use in science and mathematics classrooms, ranging from teacher-centered approach to more students-centered ones (Zakari & Iksan, 2007). One of such methods according to Oloruko-oba, (2001) is Cooperative Learning Strategy. Maden, (2011) defined cooperative learning strategy as a form of instructional method, which requires students to work collaboratively in small groups by helping each other to learn a given task. Alternatively, cooperative learning is further defined as a type of student-centered teaching where a group of students work together to achieve a common goal (Gumel, 2015). Cooperative learning is a process in which students create, analyze and apply concepts. Here, students learn lifelong concepts that will be useful both inside and outside the school. They work as a team, combining their knowledge and social skills. Students are often placed in both homogeneous and heterogeneous groups and asked to accomplish a common goal. Each team member is assigned part of the content to be learnt and is not only responsible for their learning, but the other group members' learning as well. Students work until each group member successfully understands all concepts and then the assignment is completed (Timayi, Bolaji & Kajuru,2015)

The idea of cooperative learning according to Oloruko-oba (2001) is based on the premise that an individual can only achieve his/her goals, if the other members of the group with whom he/she work together with, can equally attain their goals. Johnson and Johnson (2009) also reported that cooperative learning results in a greater effort for improving the academic performance of students, more positive interpersonal relationships and greater psychological health than competitive or individual learning effort. The use of cooperative learning strategy as a paradigm shift from the traditional or

chalk and talk to collaborative interaction, student-centered mode of learning and teaching. In other words cooperative learning strategy represents a change from individual learning to social learning (Zakariah & Iksan, 2007). In regard to the foregoing, several model of cooperative learning strategies had been advocated, one of which is Jig-saw Cooperative Learning Model.

Jigsaw is a cooperative learning models that was developed by Elliot Aronson and his colleagues in 1978. This is one of the learning strategies under cooperative learning in which, the content of the lesson is subdivided into different parts of information and then given to groups of students who would later explain to each other their parts and results in the whole jigsaw puzzle to be completed (Aronson 2008). In Jig-saw technique, students are divided into small groups of 5-6 known as the Jigsaw groups, and the concept to learn is broken into segments. Each student in the Jigsaw group is assigned a segment to specialize on as all students with same topic or segment form the expert groups. After the session, they reconvene in their Jig-saw groups where each expert explains his/her topic to other member of the Jig-saw group after which they take up quiz individually without help or assistance from the other group members. The scores of the individual members are summed up to form the group scores which are used to reward the best group (Achor & Wude, 2014).

In Science Education, the Jigsaw method is reported to be used in classes more often than other collaborative learning methods, especially in Biology, Chemistry, Physics, Mathematics and the Earth sciences. This is because the Jigsaw method is considered to enhance cooperative learning by making each student focus on a particular topic (Johnson, & Johnson, 2009). This study investigates the effect of Jigsaw IV Cooperative

Learning Strategy on Students' Perception, Retention and Academic Performance in Zaria Educational zone Kaduna State, Nigeria.

However, students' perception about particular concepts is one of the mental processes or skills human beings engage in. It is a cognitive activity in learning which is seen as the process of making sense out of something (Agogo, Ogbeba & Damkor-Ikpa, 2013). Idris (2011) sees perception as a process through which man continues to interact with environment, thereby, experiencing a form of strong base of knowledge that built up an individual. Students' perception about a concept can be positive or negative towards the teaching of science (Shafiu, 2014). Studies have shown that when several individuals confront an object or thing in their environment, or concepts in their subject area, the input of information that impinges on their respective sense organs, (eyes, ears and so on) is the same for every individual, though they perceive differently (Shafiu, 2014).

Furthermore, studies of Samba and Eriba (2012); Agogo and Onda (2014) revealed that science students perceive Organic Chemistry to be abstract and difficult to learn, as such they perform relatively low in Organic Chemistry. Charania, Kausar, and Cassum (2001), likewise investigated students' perception of learning in a Jigsaw method-based class, and report that when students discussed their specific topic within their expert group; they increased in conceptual understanding, developed self- confidence, and enhanced communication skills and positive perception regarding the topic and the subject at large.

Moreso, Ortese, Yaweh and Akume (2006) posited that learners' perception is often affected by a number of factors, such as interest, lack of effective teaching strategy, motivation, attention, self concept as well as thinking and creativity. This is why Agogo

and Onda (2014) observed that what may appear difficult to somebody may be easy to another person because the concepts of easiness or difficulty as perceived by somebody are dynamic. Whatever is the case, concept difficulty invariably affects students' performance in such a subject. Therefore, when desired intervention is not given in terms of effective teaching and learning strategies, Chemistry students would continue to have negative perception that organic chemistry is a difficult and abstract concept.

In view of this, since in JigsawIV Cooperative Learning Strategy, the teacher introduced the lesson after grouping the students into a teams of 5-6 members each, the teacher gave them task to perform and re-taught of concepts considered difficult to understand or missing part of the lesson after individual assessment, allowed the students to construct their knowledge, analyzed such knowledge and applied it to a real life situation. This enhanced students' positive perception about Organic Chemistry concepts.

Retention on the other hand, refers to what is learned minus what has been forgotten (Mang & Mankilik, 2001). Bichi (2002) opined that anything which aids meaningful learning improves students' retention and while things that lead to interference among learned materials decrease the speed and efficiency of learning and accelerates forgetting. Retention as defined by Yero, (2011) is the ability of a learner to recall, remember and recollect a body of knowledge after passing through instruction. Idris, (2014) also observed that, retention is the ability to keep and consequently remember things or materials experienced or learned at a later time. Materials to be learned depend on the strategy used in teaching and have an effect to the quality of retention in terms of their meaningfulness, familiarity and image evoking characteristics (Abdullahi, 2015).

Low academic performance as well as retention amongst students in Sciences seems to be as a result of use of teacher's-centered method which leads to poor academic retention, performance and acquisition of requisite skills (Usman, 2010). The Jigsaw model is one of the modern strategies that is students'- centered and enhanced meaningful learning through students' interaction in groups of 5-6 to construct their own knowledge, share ideas and complete a given task assigned to them. Studies revealed that, lesson which applied the Jigsaw model was shown to be effective both in cognitive and affective characteristics including meaningful learning, enhanced academic performance, retention; positive learning attitude, interest, self-respect, self-learning ability, confidence, task commitment, sociability, and so on (Kilic,2008; Sahin, 2010; Yusuf, 2011 & Gumel, 2015).

According to Hornby (2010), Academic performance refers to student's success in meeting short or long term goals in education. Sani (2007), defines academic achievement as an accomplishment or proficiency of performance in a given skill or body of knowledge. Adediwura and Tayo (2007), viewed academic performance as the knowledge attained or skills developed in school subject designed by test and examination scores or marks assigned by the subject teachers. It can be considered as a demonstrating ability of students to comprehend, analyze, apply, synthesize and evaluate Organic Chemistry information. Usman (2010) note that, poor achievement recorded in sciences could be attributed to the teaching method which does not allow students to demonstrate their abilities. According to Zakaria, Solfitri, Daud and Abidin (2013) students in a jigsaw cooperative learning activity, gained cognitive and affective development in science after their discussion, explanation they gave to one another at

both expert and home groups. However, teacher-centered method (lecture method) was used in this study to teach the control group in order to compare the performance of students with those exposed to JigsawIV Cooperative Learning Strategy.

Therefore, Lecture method of instruction is teacher-centered, characterized by the teacher talking to the class most of the time, while the students listen, take down notes and occasionally ask questions (Lakpini, 2006). It is the teaching technique in which a person usually, the teacher, presents a spoken discourse on a particular subject. The teacher does much of the activity in form of talking and writing while the students listen (Kelly, 2009). The effectiveness of this method is that, it requires clear and good command of language and good ability to write. It also saves time and energy, not expensive, saves teacher a lot of challenges in class and it allows handling of large class and easy coverage of syllabus (Gumel, 2015). Though in this method, different ability groups are not properly taken care of in class, it is boring to the students, encourages rote learning among others. As such, the researcher adopted Jig-saw(IV) Cooperative Learning Strategy in teaching and Learning of Organic Chemistry Concepts, in Zaria Education Zone Nigeria to determine its effects on students' Performance.

Globally, there have been debates on students' performances in Science and Mathematics with respect to gender, which has continued to be of interest and inconclusive (Stoet, & Geary, 2013). Gender has been identified as one of the factors influencing students' performance in sciences at senior secondary school level. Olson (2002) reported that, female students performed better than males students when taught Mathematics and sciences using cooperative learning. Sadker in Lakpini (2006) revealed that male students received more criticism from their teachers than their female counterparts as such that

affects their performance in sciences (chemistry). Contrarily, Khairulanuar, Nazre, Sairabanu and Norasikin (2010) found gender differences in favour of male students. Becker in Lakpini (2006) opined teachers spoke more frequently to boys, asked the boys more questions, praised boys for quality work and girls for neatness. Even though, Ajaja and Eravwoke (2010) and Timayi *et al* (2015), reported that gender had no effect on academic achievement of students in cooperative learning. These contradictory findings have caused for inclusion of gender as one of the moderating variable for this study. This study investigated the effects of Jig-saw(IV) Cooperative Learning Strategy on students' gender among students taught Organic Chemistry at Senior Secondary Schools in Zaria Educational zone.

1.1.1 Theoretical Framework

Jig-saw(IV) Cooperative Learning Strategy is based on the theory of Constructivism, Peer Learning Theory of Piaget (1967) and Social Learning Theory of Vygotsky (1978). The constructivism is a school of thought that believes in learners actively constructing their own knowledge and understanding using previous knowledge and interacting with instructional materials under the guidance of the teacher. Constructivism is a theory based on observation and scientific study about how people learn (Fosnot, 1996).

Constructivism says that, people construct their own understanding and knowledge of the world through experiencing things and reflecting on those experiences. When we encounter something new, we have to reconcile it with our previous ideas and maybe changing what we believe, or maybe discarding the new information as irrelevant. In any case, learners are active creators of their own knowledge. Similarly, in Jigsaw (IV)

cooperative learning strategy, the teacher introduces the lesson to the students so as to provide them with anchoring idea that would link the previous experience with the task at hand and reflecting on those experiences through active participation in the lesson. Here the students are given the task to perform after discussion at expert group, returns to the home group and explain the portion learned to other members of the group. This therefore makes them to be active creator of their knowledge.

The peer learning theory of Piaget, (1967) believed that, learning improved with the help of peers. Piaget found that, children need to discuss their findings as well as having stimulating environment in which they learn in peers. Learners need to be active, have hands-on opportunities, and not to become the least passive as the case may often be. He thought peer interaction could help students to recognize contradictions and interpretation of a problem. The dialogue creates cognitive gains and allowed students have a relationship built on cooperation. Piaget opined that teachers should create an enabling environment of mutual respect such as that of Jig-saw(IV) Cooperative Learning Strategy where learners work in peer and share the knowledge acquired so as to ensure meaningful learning and mastery of the lesson. The entire group depended on the other member of the group for success. Therefore, this theory supports the use of Jigsaw IV Cooperative Learning Strategy in Science Education.

Vygotsky (1978), in his Social Cognitive Theory, reflected the structure of Jig-saw Cooperative Learning in learners. Vygotsky believed that infants were born with some level of social-cognitive ability. This ability would have enhanced as long as the children grew-up with understanding and supportive adults who encouraged their verbalization and permitted collaborative conversations. He theorized that, as learners grow, they

experience more social interaction with adults and peers. These interactions allow them to develop functions such as language skills, voluntary attention, scientific skills and memory. Vygotsky believed that the zone of proximal development of a child is the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under guidance or in collaboration with more capable peers. The zone of Proximal Development is usually determined from below what a child can learn on his/her own, and above by what a child can learn with the help of others, such as peers or teacher as seen in Jig-saw(IV) Cooperative Learning Strategy. This study adopted the theory of Constructivism, because students in Jigsaw IV Cooperative Learning Strategy are active creator of their own understanding and knowledge of the concepts given through experiencing things and reflecting on those experiences. Also, in Jigsaw IV Cooperative Learning Strategy introduction is the first step that provides an anchoring idea to understand the tasks given to them at hand.

1.2 Statement of Problem

The world is searching for a better way in which science can be taught meaningfully through activity- based Strategy. This Activity–Based Strategy can only be achieved where there are available science facilities to enhance teaching and learning of science. In developing countries, like Nigeria, most of the facilities are not readily available which promote frequent use of inappropriate teaching strategies and lead to consistent poor performance in science courses especially Chemistry (Sadi, 2014). This was further proved from the analysis made by West Africa Examination Council (WAEC, 2017), that

the performance of students in chemistry from 2007 to 2017 keeps on fluctuating and this is presented in Table 1.1

Table 1.1 The Performance of Students in Chemistry from 2007-2017 in Kaduna State.

Year	Number of candidate that sat for WAEC	Number of students (pass)	Number of students (fail)	% of students (pass)	% of students (fail)
2007	182659	39125	143534	21	79
2008	228953	80355	148598	35	65
2009	250099	85150	163949	34	66
2010	289520	84520	205000	29	71
2011	326541	98215	228326	30	60
2012	367562	120560	247002	33	67
2013	428034	149812	278222	35	65
2014	659132	204330	454802	31	69
2015	866616	251319	615297	29	71
2016	791227	245280	545947	31	69
2017	758849	295951	462898	39	61

Source: WAEC Office Kaduna, Kaduna State, (2018)

Statistic**s** in Table 1.1 indicates that the average percentage of students' pass scores is 35% and the failure rate of 74%**.** This implies that, performance of student in Chemistry would continue to decline, if the right and desired intervention is not given in terms of effective teaching and learning strategies.

Several attempts have been made to investigate the effectiveness of teaching methods on academic performance in Science Education and findings revealed that innovative methods such as Discovery, Science Process Approach, Problem Solving Learning

Strategy, Laboratory, Cooperative learning strategy and so on were more effective in enhancing students cognitive performance in science at SS level than conventional method (Ibrahim, 2012; Bitrus, 2012 & Attah, 2014), yet the performance of students in sciences (Chemistry inclusive) kept on declining.

Many studies have also been conducted in the area of gender related differences in academic performance and retention in secondary school Chemistry. It has been noted that male students perform better and retained Chemistry concepts more than female students. Other studies revealed the superiority of female students in Chemistry achievement and retention over the male students. Also no gender differences in academic performance and retention have also been reported. These contradictory evidences in academic performances and retention of male and female students in chemistry have resulted on the need to search for effective methods of teaching that can ameliorate the aforementioned problem in teaching and learning of chemistry concepts which called for the adoption of Jig-saw(IV) Cooperative Learning Strategy.

In promoting greater performance, several studies reported that Jigsaw cooperative learning enhances academic performance and fosters greater retention of learning outcomes ((Sousa, 2006; Moore, 2008; Kagan & Kagan, 2009; Maden, 2011). However, most of these studies were carried out either at higher institutions or primary schools and are mostly foreign. Jigsaw IV Cooperative Learning Strategy, in this study is used because, it involves introducing the lesson to the learners so as to provide them with anchoring idea that serves as a prior knowledge, assigning a task to every student in a Jigsaw group becomes an “expert”, such that he/she is actively participate and responsible for the explanation given to the other group members (home group) and re-

teaching of material after individual assessment makes it better than other types of jigsaw and would be used to examines its effect on senior secondary school student using Organic Chemistry concepts in Zaria Educational Zone. Therefore, this study investigates the effects of Jigsaw (IV) Cooperative Learning Strategy on students' perception, retention and academic performance in Organic Chemistry in Zaria Educational Zone, Kaduna State Nigeria.

1.3 Objectives of the Study

The objectives of the study are to:

i. determine the effects of Jigsaw(IV) Cooperative Learning Strategy on Students' Academic Performance in Organic Chemistry concepts among Senior Secondary Schools in Zaria Educational Zone.

ii. examine students' perception of organic chemistry concepts before and after exposure to Jigsaw(IV) Cooperative Learning Strategy and Conventional Method of Teaching among SS II Students in Zaria Education zone?

iii. compare the retention ability of students taught Organic Chemistry using Jig-saw(IV) Cooperative Learning Strategy and those taught same concepts using CMT at Senior Secondary Schools of Zaria, Kaduna State, Nigeria.

iv. determine the gender- related difference in academic performance between SSII male and female students in Organic Chemistry using Jigsaw IV Cooperative Learning strategy.

1.4 Research Questions

The study was guided by the following research questions.

(i). is there any difference between the mean academic performance scores of senior secondary school students taught Organic Chemistry using Jigsaw(IV) Cooperative Learning Strategy and those taught same concepts using Conventional Method of Teaching?

(ii) what is the students' perception of organic chemistry concepts before and after exposure to Jigsaw(IV) Cooperative Learning Strategy and Conventional Method of Teaching among SS II Students in Zaria, Kaduna State?

(iii) is there any difference between the retention ability of students taught Organic Chemistry concepts using Jigsaw(IV) Cooperative Learning Strategy at Senior Secondary Schools in Zaria, Kaduna State, Nigeria?

(iv) is there any difference between the mean performance scores of male and female students taught Organic Chemistry using Jigsaw(IV) Cooperative Learning Strategy at SSII level?

1.5 Null hypotheses

The following null hypotheses were formulated and tested at $P \leq 0.05$ level of significance.

HO1: There is no significant difference in the mean academic performance scores of students taught Organic Chemistry concepts using the Jigsaw(IV) Cooperative Learning Strategy and those taught same concepts using the Conventional Method of Teaching.

HO2: There is no significant difference in students' perception of Organic Chemistry concepts before and after exposure to Jigsaw(IV) Cooperative Learning Strategy and Conventional Method of Teaching among SS II Students in

Zaria, Kaduna State

HO3: There is no significance difference in the retention ability of chemistry students taught Organic Chemistry concepts using Jigsaw(IV) Cooperative Learning Strategy and those taught same concepts using the Conventional Method of teaching at Senior Secondary Schools in Zaria, Kaduna State, Nigeria.

HO4: There is no significant difference in the mean academic performance scores of male and female students taught Organic Chemistry using Jigsaw(IV) Cooperative Learning Strategy at SS II level.

1.6 Significance of the Study

This study titled effects of Jig-saw(IV) Cooperative Learning Strategy on students' perception, retention and academic performance in Organic Chemistry concepts in Zaria Education Zone, Kaduna State, would be of benefit to:

Chemistry Students: This study would help secondary school students identify the learning strategy that enhances performance in Organic Chemistry. It is hoped that the use of Jig-saw (IV) Cooperative Learning strategy for teaching Chemistry in senior secondary schools would enhance their academic performance and retention of what they learn.

Chemistry Teachers: The findings of this study would be beneficial to secondary school Chemistry teachers by helping them on the use of learning strategies which arouse the interest of learners and with high participation of the learners. Information from this study would also help Chemistry Teachers to improve upon their teaching effectiveness through the use of Jig-saw (IV) Cooperative Learning Strategy as effective instructional strategy in their field.

Head of Departments: Jigsaw(IV) Cooperative Learning Strategy would provide an impetus for the heads of departments to recommend the effective method to be used by teachers. This study would inform the teacher educator about effective teaching strategies in preparation of the teachers and thus enhancing students' performance in Organic Chemistry concepts.

Higher institutions of Learning: The institutions of higher learning where chemistry teachers are trained would make use of the Jigsaw (IV) Cooperative Learning Strategy so as to equip them to produce more effective and teachers who would in turn help students re-construct knowledge on their own.

Professional Bodies: Findings of this study would be useful to professional bodies concerned with outcomes of research especially those interested in Instructional innovations. Professional bodies such as Science Teachers Association of Nigeria (STAN) and Nigerian Educational Research and Development Council (NERDC) that carry out seminars, workshops, and research activities might find the results of this study useful and incorporate them into their instructional packages.

Curriculum Developers: Curriculum Developers who develop syllabuses or syllabi and recommend effective methods of instruction would incorporate the teaching strategy as reflected in this study, and also the findings of this study would be used to clarify, modify, support or refute the existing claims on abstract nature of Organic Chemistry concepts.

Researchers: It would help to initiate further studies into other teaching strategies not only in Chemistry, but other sciences with a view to equipping professionals on how to enhance academic performance and creativity of students at all levels of education.

1.7 Scope of the Study

This study investigated the "effects of Jigsaw(IV) Cooperative Learning Strategy on Senior Secondary School Chemistry students' perception, retention and performance in organic concepts in Zonal Expectorate Division, Zaria". This study was delimited to SS II Senior Secondary Schools Students offering Chemistry. Two intact co-education schools with a sample size of 234 students out of total population of 1,154 were used for the study. Quasi-experimental research design with emphasis on pretest, posttest and post-post test was used. Six Organic Chemistry concepts are used for the purpose of generating data for the study. These concepts were Hydrocarbons, Functional group, Homologous series, Alkanes, Alkenes and Alkynes. These concepts were selected based on the finding of Samba and Eriba, (2012), and Agogo and Onda, (2014) that students find these concepts to be difficult as learners only study them by memorization. The instruments used were Organic Chemistry Performance Test (OCAT) and Organic Concept Perception Questionnaire (OCPQ). Mean, Standard Deviation, t-test, ANCOVA and Kruscal Walli's statistics were used in analyzing the research questions and the null hypotheses.

1.8 Basic Assumption

The study is based on assumptions that:

1. Students performance would improve after exposure to JigsawIV Cooperative Learning Strategy;
2. Organic concepts would be retained when JigsawIV Cooperative Learning Strategy is used ;

3. Students Perception would change when JigsawIV Cooperative Learning Strategy is used in teaching of Organic Chemistry concepts in senior secondary school students in Zaria.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter reviews literature on the effects of Jig-saw(IV) Cooperative Learning Strategy on secondary school students perception, retention and academic performance in Organic Chemistry concepts in Zaria Education Zone, Kaduna, Nigeria. The review focused on the following sub-headings:

2.2 The Teaching of Chemistry in Nigeria Secondary Schools

2.3 Science Teaching Methods

2.4 Concept of Cooperative Learning Strategy

2.5 Concept of Jigsaw IV Cooperative Learning Strategy

2.6 Jigsaw IV Cooperative Learning Strategy and Perception in Science Education

2.7 Jigsaw IV Cooperative Learning Strategy and Retention in Science Education

2.8 Jigsaw and Academic Performance in Science Education

2.9 Gender and Students' Performance in Science

2.10 Overview of Similar Studies

2.11 Implication of Literature Reviewed for the Present Study

2.2 The Teaching of Chemistry in Nigeria Secondary Schools

Chemistry is one of the most important subjects in science not only because of its numerous and fundamental connections with other branches of science, but also of its wide range influence on the way we live (Abdullahi, 2015). Fashiola, (2008) viewed Chemistry as the science of materials in the natural and built environment and that it is pivotal to the development in the natural world. Chemistry is one of the means by which

It deals with all of the substances making up the environment and the changes these substances undergo (Abdullahi 2015).

According to Gilbert (2009), Chemistry comprises of four components. These include;

i. The processes used to obtain (discover or create) chemical knowledge;
ii. The general concepts and specific ideas so produced;
iii. The application of that knowledge in understanding and changing the world;
iv. And the implication of that understanding and change for individual and societies.

Gilbert (2009), also added that understanding Chemistry requires understanding; the nature of Chemistry, its norms, values, and methods, the key theories, concepts, model of Chemistry, how Chemistry and Chemistry-based technologies relate to each other, and appreciating the impact of Chemistry-related technologies on society.

The revised edition of Nigerian Secondary School Chemistry Curriculum as observed by Federal Ministry of Education (FME, 2007) expects among other things that chemistry would 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. Develop reasonable level of competence in Information Communication Technology application that will engender entrepreneurial skills;

v. Apply skills to meet societal needs of creating employment and wealth and

vi. Be adequately prepared for further studies in Chemistry.

According to Olatoye and Affuwape, (2004); Ibrahim, (2006); Mohammed (2007) and Abdullahi, (2015), the teaching of Chemistry in senior secondary schools of Nigeria has the following significance;

i. Chemistry helps in improving the quality of life. Today, studying chemical process around us such as lightening matches, cooking, burning of fire wood, rusting of metals among others. Chemistry allows man to understand his environment and concept of matter and different changes that the matter undergoes.

ii. Chemistry provides vocational preparation of individuals who become personnel in the various fields such as Medicine, Pharmacy, Chemical Engineering, textiles environmental monitoring and petroleum industries; among others, these are essential particularly in the developing country like Nigeria.

iii. Chemistry education is of practical aesthetic and intellectual value to students. It provides useful chemistry concepts and principles. Chemistry is also directly related to other natural sciences such as Physics and Biology. Hence, the encouragement of the learning Chemistry especially at the senior secondary school levels is of paramount importance and one way by which this can be achieved through the use of appropriate instructional strategy.

When compared to other curriculum documents, it is evident that the Nigerian Chemistry Curriculum has given opportunity for students to develop scientific skills, attitudes and

apply such knowledge for personal decisions when faced with everyday problems (Akintunde & Lawal, 2008; Abdullahi, 2015). Science in general and Chemistry in particular need to be taught in such a way students are engaged to develop the scientific skills, knowledge, attitude and so on. However, Chemistry has been taught over the last 40 years in Nigeria, yet students have difficulty in understanding most of the Curriculum content to their everyday lives (Abdullahi, 2015).

Some studies in Nigeria, such as Ogunmade, (2006); Lawal, (2008); Adewumi and Akiniyi, (2010); Agogo and Onda (2014) and Abdullahi, (2015) indicated that teachers are faced with problems of large classes and they lack adequate resource to make learning concrete and accessible to student. There is lack of appreciate instructional strategy to teach abstract concept such as Organic Chemistry in Chemistry. Despite various suggestions for improvement, low standard remains. From these fact, it appears that the low standards in students' performance especially in WAEC/NECO examinations could be attributed to the subsequent factors outlined.

Furthermore, one of main objectives of Chemistry Education is to help students use school knowledge to explain chemical phenomena that occur in everyday life. Being familiar with chemical representations such as formulae, symbols, equations, and structures is essential for understanding especially the basic Organic Chemistry concepts (Kozma in Abdullahi, 2015) and transferring it to everyday life. However, many researchers have reported students' alternative conceptions about basic Chemistry concepts such as acids and bases (Igboegwu, 2012), mole concept (Staver & Lumpe, in Abdullahi, 2015), solutions (Çalık, Ayas & Roll, 2007) the structure of matter (Haidar &

Abraham, 1991), chemical equilibrium (Demircioğlu, in Abdullahi 2015), Organic Chemistry concepts (Eriba & Samba, 2012; Agogo & Ortor2013).

Therefore, Organic Chemistry is the study of hydrocarbons and their derivatives. Lowrie and Ferguson (1978) defined Organic Chemistry as "the Chemistry of living things", but nowadays it has been extended to include all compounds containing C-H bonds. Mathew (1996), on his own sees Organic Chemistry as the aspect of Chemistry that studies chemical compounds containing carbon elements with the exception of carbon (iv) oxides (CO_2) and carbon (ii) oxides (CO). In general, Organic Chemistry is the branch of Chemistry that deal with the study of Carbon and its compounds with the exception of its oxides such as carbon (iv) oxides (CO_2) and carbon (ii) oxides (CO); its trioxocarbonate (iv) salt such as sodium trioxocarbonate (iv) (Na_2CO_3), Potassium trioxocarbonate (iv) (K_2CO_3), Calcium trioxocarbonate (iv) ($CaCO_3$) and metallic hydrogen trioxocarbonate (iv) such as Sodium hydrogen trioxocarbonate (iv) $NaHCO_3$, potassium hydrogen trioxocarbonate (iv) KHCO3 and so on.

Many scholars have identified Organic Chemistry as a hard course and many secondary and college students who wish to pursue a career in Chemistry and medicine must have a solid understanding of Organic Chemistry and perhaps more importantly to the students, a good grade in Organic Chemistry. However, the difficulty of the Organic Chemistry materials prevents many students from continuing with this career path (Gilbert 2005; Uttal & Doherty 2008; Michael, Melanie, Ghislain & Jodie, 2013). Without understanding the concepts, students memorize a large vocabulary of molecules and rules to fake an understanding of the organic structures in order to survive in the course. Organic Chemistry is commonly found problematic and Chemistry students eventually develop a wide range of negative perception which in turn affects their performance in Organic Chemistry (Habraken in Anne & Peter, 2012).

Anne and Peter, (2010) indicated that the nature of Chemistry concepts and the way the concepts are represented (macroscopic, microscopic, or representational); teaching method by which students learn are potentially in conflict with the nature of science, or the methods by which teachers have traditionally taught (McCormick & Li, 2006; Simsek, 2009); teachers` lack of an accurate awareness of their pupils' prior knowledge, misconceptions and level of cognitive development, and students' perception and approach to learning, causes poor performance of students in Chemistry (Anne & Peter, 2010).Therefore, researchers in Science Education have focused on developing alternative methods for improving students' understanding and remedying their alternative perception (Agogo, & Onda, 2014). One of these developed innovative methods is Jigsaw (IV) Cooperative Learning Strategy. In line with this, the study examined the effect of Jigsaw IV Cooperative Learning Strategy on students' perception, retention and performance in Organic Chemistry in Zaria, Kaduna State.

2.3 Science Teaching Methods

Teaching is a process of imparting knowledge or idea that involves some activities on part of the teacher and learner. The prime functions of a teacher is to build up the services of intellectual capital and engage in the systematic assemblage of step by step facts called methods. Teaching method can be defined as a well known procedure with more or less defined steps which tend to promote over all teaching strategies. According to Aniaku, (2014), teaching method describes various ways information is presented to the students specifying the nature of the activities in which the teacher and the learner will be involved during the teaching and learning processes. The main purpose of teaching is the transfer of knowledge.

The poor performances of students in external examinations have been attributed to poor teaching methods among other factors (Aniaku, 2014). To improve on the performance of students, many researchers have recommended the use of effective teaching methods as a remedy for students' poor performance. Ashiru, (2015) noted that effective teaching makes learning meaningful, while poor teaching leads to poor learning and resultant poor performance. An effective instructional method is that which stimulates students' interest and involves students' active participation. An effective teaching is designed to stimulate learning and improve thinking skills. Effective teaching ranges from the most transmission of factual knowledge to a process that transforms both the teacher and the students through critical thinking. There are different types of teaching methods such as lecture method, demonstration, laboratory method, discussion, problem-solving, fieldtrip, and cooperative and so on. These different methods are different ways of imparting knowledge to the learner.

i. Lecture Method

Lecture method of instruction is a teacher-centered, characterized by the teacher talking to the class most of the time, while the students listen, take down note and occasionally ask questions (Lakpini, 2006). According to Shafiu, (2014), the main pre-occupation of the teacher who adopts this method is talking, giving facts, asking or answering questions or writing either on the chalk or pen board or on transparencies. Adopting this method presupposes that the teacher is the main repository of the knowledge to be transmitted and the students are the recipients. If used effectively, this method provides an opportunity for the teacher to demonstrate his mastery of the subject being discussed.

Effectiveness of lecture method depends on the types of student, circumstance of the class, the subject, educational purposes and teachers own characteristics and skills (Atadoga & Onoalapo, 2008). At least eighty percent (80%) of scientific information is passed on to students through lecture method (Aliyu, (1982) & Brent,(2003)). Lecture method helps science teachers cover a large part of the syllabus to a large class size in a very short period. This is however detriment to students learning, but the teacher may not have a choice being driven by the pressure to cover the syllabus and thus prepare the students for the external examination which is the only qualifying measure to the next level or employment. Atadoga and Onoalapo (2008) further noted that lecture method has some basic common problems which are;

i. The teachers' disposition: Since the teacher is the authority of subject matter as well as controller of students' behavior, the communication is only one way. The students have limited opportunity to express their problems and needs. If the teacher is being misunderstood, there is little chance of correcting students' misgivings and thus students are alienated.
ii. Communication problems: Delivery is the most personal in lecture method due to individual differences. For effective teaching, good communication must be maintained between the teacher and the students. This will inculcate clarity of voice, simple and understandable language style, monitoring the students by pausing regularly to explain and ask questions.
iii. The preparation, organization and presentation: This has to do with clear aims and objectives of the course and the student's previous knowledge will enhance good preparation, lecture materials should be put together ahead of lessons, updating it

as necessary. The teacher's presentation should be such as well aid students to develop and maintain interest in the subject.

Studies conducted on lecture method show that lecture method can promote meaningful learning if properly employed (Idris 2014). Others such as James, (2000) and Usman, (2010) argued that lecture method does not promote meaningful learning of science and that differences in students' ability are not considered because it cannot satisfy the difference in individuals such as slow and fast learners. Therefore, this study examines the effect of Jigsaw IV Cooperative Learning Strategy on academic performance of students in organic chemistry, though lecture method was employed as a control in this study for the control group.

ii. Demonstration Method:

Simply means to display something (Aliyu, 1982). Ukwueze, (2012), defined demonstration as a method in which steps in manipulative tasks are shown gradually with explanations to the students. In order for students to comprehend new ideas, concepts, or skills and construct their own knowledge, they need to see clearly examples of what the new idea or skill represents. Generally in science, acquisition of skills for tackling life's problem is highly valued. Demonstration involves the introduction of new skills that is accompanied with a lot of explanation and showing how something works or is been done. It can be employed in finding facts; identifying problems and displaying materials. Under demonstration, a range of activities can be planned starting from showing the correct use of science apparatus, illustrating a technique to planning a manipulation of equipment and material in order for the pupils to observe a scientific phenomenon.

However, demonstration method limits the students from developing manipulative skill and may not be satisfied psychologically. It also emphasizes sight alone which is not sufficient to provide the scientific information the students require. Investigation carried out has revealed that if well planned, demonstration method can also be more efficacious than the traditional lecture method (Obeka, 2010).

However, J4CLS involve placing the students in group of 3-6, and giving them task to perform. This may enable them to develop manipulative skills as the students are actively involved in constructing their own knowledge through interacting with one another in a jigsaw group. This makes it better than the demonstration method. In view of this, this study determines the effects of Jigsaw IV Cooperative Learning Strategy on students perception, retention and performance in Organic Chemistry in Zaria, Educational Zone, Nigeria.

iii. Laboratory Activity Method:

According to Bajah, (1983) class activity is an experimental subject. Most science educators believe that science is not really science unless it is accompanied by experimentation and laboratory work. For most science subjects therefore, the laboratory is seen as a focal point for the study of science. Experimentation is so much a part of science that it is difficult to conceive a science program without an experimental activity. Chemistry like all other sciences stresses the role of laboratory work as an integral part of the science lessons. Science teachers should stress the procedures now generally known as the experimental method. Applied to most of the experiment in Chemistry, the methods consist of;

i. Identification of a problem

ii. Formulation of hypotheses

iii. Testing of hypotheses with accompanying observation

iv. Concluding with respect to specific observation

v. Predicting and generalizing the ideas learnt

The experimental method when properly applied is flexible and readily adapted to all types of situations even outside science. The experimental method sometimes also called the scientific methods is no more than the application of common sense to the solution of everyday problems.

Laboratory experiments and exercise are often used interchangeably. According to Shafiu (2014), many activities carried out in science laboratories are designed to either demonstrate certain principles or familiarize the students with certain piece of apparatus or skill. However, laboratory experiment differs from exercise in the information given to students in an experiment; a student does not generally know what the result of investigation will be. In an exercise, the student is told what the outcome of his work should be and how to attain them. In effect then, the laboratory exercise is very highly structured while a laboratory experiment is less structured. It is important for a science teacher to bear both approaches in mind in order to attain the objectives of teaching science. To conduct a good Chemistry class activity, the teacher should bear the following in mind;

a. Selecting laboratory activities

b. Giving directions for laboratory activities

c. Providing materials for laboratory activities

d. The teachers role during laboratory activities

e. Use of data collection during laboratory activities

Studies conducted on the efficacy of laboratory method have shown that it can enhance students academic performance in science be it indoor or outdoor laboratory instruction Stanley, (2008); Duniya, (2009), Usman, (2010) and Attah, (2014). This study investigates the effects of Jigsaw(IV) Cooperative Learning Strategy on perception, retention and performance in organic chemistry.

iv. Problem Solving Method

Problem-solving teaching strategy as viewed by Bichi (2002) is an instructional strategy in which problems of scientific nature or problems related to the real world are carefully formulated and presented to students. It is a means by which an individual makes use of a previous knowledge to satisfy the demand of a new unfamiliar situation (Roberts in Shafiu, 2014). Eze, (2001) observed that, a systematic approach to problem-solving encourages good learning habits, contributes to clarity in thinking, enhances logical reasoning and promote intellectual development. More so, the process of solving problems allows the students interact with one another and with instructional materials and consequently, construct knowledge, acquire science process skills (Adamu, 2011).The goals of problem-solving teaching strategy are to :

i. Help the students develop flexible knowledge

ii. Develop effective problem solving skills through self directed learning

iii. Develop effective collaboration skills and intrinsic motivation, (Barrowa in Shafiu, 2014).

The use of Problem-Solving Teaching Strategy (PSTS) like other student-centered approaches has been motivated by recognizing the failure of traditional method of instruction and the emergence of deeper understanding of taught concepts (National Educational Resources Centre, NERC,2009). PSTS actively engage the students in constructing knowledge. The five core characters of PSTS are:

a. It consists of student-centered learning
b. Learning occurs in small groups
c. Teachers act as facilitators
d. Problem stimulates the development and use of problem-solving skills of intellectual curiosity
e. New knowledge is obtained through self –directed learning.

In problem-solving strategy, some models are involved is identified by Gice (2012) who developed six- step model of problem-solving strategy upon which this study was based. The steps are:

Step 1. Identify the problem
2. Analyze the problem
3. Develop solution
4. Implement solution
5. Evaluate the results
6. Standardize the results

Also, Salvaranthum (1990) has come out with a model in problem solving strategy called the step-wise model outlined as :

Stage A . Data handling

Stage B . How to start

Stage C. develops, organize and rearrange solutions

However, Problem Solving Strategy concentrates more on the whole group of students in the classroom, without considering the differences in individual performance as seen in Jigsaw(IV) Cooperative Learning Strategy. Therefore, this study investigates the effects of Jigsaw(IV) Cooperative Learning Strategy on students' perception, retention and performance in Organic Chemistry in Zaria, Kaduna, Nigeria.

v. Discovery Method:

Discovery method is one of the strategies of science teaching. Many science educators have consistently advocated for this method as they believe that science should not be taught to a child but that, he should be left to discover it. A modern science curriculum stresses students' involvement in science activities through discovery experience. Aliyu, (1982) defined discovery method as an unstructured exploration in the laboratory in which student, through his mental processes such as observing, measuring, classifying and so on, can draw valid conclusions from data which he has gathered. Two types of discovery method are recognized;

i. **Guided Inquiry:-** which consists of an instructional mode which can be inductive or deductive in nature. When the general principle is given and the students require using the principle in order to discover the solution to a specific problem, the guided inquiry is employed through deductive method. On the order hand, when the solution to a specific problem is given and the student is required to discover the

general principle on which the solution is based, the guided inquiry is adopted through inductive reasoning.

ii. **Unguided Inquiry**:- this is however, when neither the general principle nor the solution is given and the student is required to discover both principle and the solutions, the teacher in this particular instance employs unguided inquiry which is also known as pure discovery. As guided inquiry and unguided inquiry involves finding out, they both employ discovery method. These two types of discovery method require student to engage in relatively sophisticated mental processes including;

   i. Formulating problems for investigation
   ii. Formulating hypotheses to guide investigation
   iii. Designing experiment to collect data
   iv. Synthesizing knowledge in form of generalization or finding solution to a problem
   v. Possessing certain scientific attitude, such as objectivity, curiosity and open-mindedness (Idris, 2014).

An investigation conducted by Ajewole in Idris (2014) showed that guided discovery enhanced students' academic performance in learning. Obeka, (2010) opined that discovery/ inquiry method of instruction had a significant effect on students academic performance in sciences.

2.4 Concept of Cooperative Learning Strategy

Cooperative learning strategy according to Sharan (2010), is a successful teaching strategy in which small groups each comprises students with same or different levels of ability use a variety of learning activities to improve their understanding of a subject. Each member of a team is responsible, not only for learning what is taught, but also for helping teammates learn, thus creating an atmosphere of achievement. Students work through the assignment until all the group members successfully understand and complete it. Simply put, cooperative as an approach of organizing classroom activities into academic and social learning experiences whereby students work in groups to complete a set of task collectively. Macpherson, (2007) opined that, in cooperative learning, students work together as a team to maximize the academic success of all the team members. The failure of even a single member can compromise the success of the entire team. Thus, to evaluate the functioning of the team reliably, it is necessary to consider both the performance of the individual team members and the interactions among them.

Cooperative Learning Strategy may be characterized as a learning approach in which students build small mixed or homogenous groups in classroom and other environments to assist each other in learning a certain academic subject according to a common objective in which the individuals' self-confidence is encouraged and their communication and interactions are developed in which problem-solving and thinking capacity are enhanced and in which students participate in learning process actively and teach something to each other (Gillies, 2006; Lin, 2006; Şimşek, 2007). According to Maden (2011), Cooperative learning facilitates learning process by assigning students to

small groups in which they work together to increase their own and one another's learning.

Cooperative learning is viewed as a tool for preparing students to work in teams as required in various employment settings, in the home, and in the community when there is a need to combine energies and work towards a common goal (Eilks, (2005); Gillies, 2006; Lin, 2006 & Chianson, Kurumeh & Obida (2010)). In addition to cooperative learning, it is an umbrella term for a variety of educational approaches involving joint intellectual effort by students, or students and teachers together (Baker & Clark, 2010). At all levels of education, students in cooperative situations achieved greater academic, social and psychological benefits (Johnson & Johnson, 2005). Specifically, cooperative learning has been reported to improve students' academic achievement (Beck & Chizlk, 2008; Sousa, 2006; Zain, Subramaniam, Rashid & Ghani, 2009).

Furthermore, Baker, and Clark (2010), revealed that cooperative learning strategies have the following advantages:

a. Promote meaningful learning among learners and enhance academic achievement;
b. Increase students' retention;
c. Enhance students' satisfaction with their learning experience;
d. Help students develop skills in oral communication;
e. Enhance social interaction and develop students' social skills;
f. Promote students' self-esteem;
g. Help to promote positive race relations;

h. Enhance positive interdependence of groups since each group member's effort is required and is indispensable for group success.

2.4.1 Essential Elements of Cooperative Learning

Brown and Parker (2009) stated the five basic elements of cooperative learning strategy.

1. There must be positive interdependence among the groups. This means that students must participate fully within their group. Again, each group member has a task or responsibility to play in the group hence must believe that they are responsible for their learning and that of their group.
2. There must be face-to-face promotive interaction among the groups. This means that members of the group must promote each other's success and assist one another with understanding and completion of assignments.
3. There must be individual accountability. Each student must demonstrate master of the content being studied and each student is accountable for their learning and work thereby eliminating social loafing.
4. Some social skills must be taught before embarking on cooperative learning strategy. For a successful cooperative learning to occur, social skills such as effective communication, interpersonal and group skills leadership, decision making, trust builders and conflict management skills must be taught to the learners.
5. Groups must be encouraged to assess their effectiveness and decide how their performance can be improved.

Though even with the advent of innovative learning strategy in Chemistry such as cooperative learning strategy, yet the performance of students in Sciences kept on

declining (Kagan 1994; Kelly, 2009 & Gumel, 2015). However, Isaac (2012) revealed that, one of the reason why even with the advent of innovative teaching and learning strategy such as cooperative learning strategy, yet performance of students in sciences kept on declining is due to the fact that in most of the cooperative learning models some members of the group act as passengers or social loafers and derive a benefit (generally a good grade) from the group activity. This undermines the effectiveness of the group.

Cooperative learning strategy has a number of models, one of which is Jigsaw models. The reason for the adoption of Jigsaw model is that Jigsaw Cooperative learning strategy has unique characteristics of providing optimum opportunities for the students to independently study task given to individual member of the group.

2.4. Models of Cooperative Learning Strategy (CLS)

Teachers implementing CLS in their instructions might use different models to help facilitate group interaction and improve student's academic achievement in sciences and Chemistry in particular. Johnson, Johnson and Stanne (2000), identified some of the models of CLS that have received the most attention, namely:

i. Students-Team-Achievement-Division (STAD Slavin,1990)
ii. Learning Together Model (LTM, Johnson and Johnson,1999)
iii. Teams-Game-Tournament (TGT, Devries and Edwards, 1970)
iv. Group Investigation Model (GI, Sharan &Sharan,1992)
v. Jigsaw Model (JM, Aronson,1978),

i. Students-Team-Achievement-Division (STAD)

STAD stands for student team achievement divisions; it is a collaborative learning strategy in which small groups of learners with different levels of ability work together to accomplish a shared learning goal. It was devised by Robert Slavin and his associates at Johns Hopkins University (Innovative Learning, 2009). Students are assigned to four or five member learning teams that are mixed in performance level, gender, and ethnicity. The teacher presents a lesson, and then students work together within their teams to make sure that all team members have mastered the lesson. Finally, all students take individual quizzes on the material, at which time they may not help one another. Students' quiz scores are compared to their own past averages, and points are awarded on the basis of the degree to which students meet or exceed their own earlier performance. The teacher presents new material using formal teaching: lectures, discussion, or videos.

Slavin in Gumel (2015), have designed classroom experience that would avoid superficial contact explained STAD model as:

> Pupils in each class are divided into groups with four or five member group. The groups are "heterogeneous microcosm" of the classroom containing a cross section of the people characteristics: high, middle and low ability, ethnic groups and boys and girls. The teacher is responsible for introducing a class topic assigning sub-topics to each group. Team members work out their own method for approaching problems. Individuals quizzed for their knowledge and combined team scores is obtained so that teams could complete against each other. Rewards are given on the basis of how well the group scores.

In term of learning achievement using the STAD, in a study of Keramati (2009), entitled "The effect of cooperative learning on academic achievement of physics course", it is

found that experimental group students taught by cooperative learning (STAD technique) are more successful than control group students. At this point, it is found that cooperative learning increased academic achievement of students to a higher level when compared to conventional teaching method (Keramati, 2009), similarly, a study of Yu (1998), found that subject in the cooperation tend to have higher scores on both the posttest and questionnaire measuring attitudes toward science course (Yu, 1998).

ii. Learning Together Model (LTM)

Learning Together Model is a model of cooperative learning developed by Johnson and Johnson (1999). In this model, students are put into groups of two to five members with each group working on assigned task. Class work was mainly based on the group work. The teachers' main role is to assign the tasks to groups, praise and encourage the groups. According to this model, for any learning exercise to qualify as cooperative learning, it must incorporate the five basic elements of CLS identified above (p.39). According to Johnson and Johnson in Samaila (2015), in learning together method, the following options must be put in place:

1. Determining the instructional objectives
2. Deciding the group size
3. Dividing the students in to groups
4. Arranging of the class
5. Planning of educational materials to provide dependence.
6. Giving the roles to the group members in order to provide dependence.
7. Explaining of the academic work.
8. Creating the positive objective dependence

9. Individual evaluation
10. Providing the cooperation among the groups.
11. Being explained the criteria necessary for performance
12. Determining the required behaviours for success
13. Guiding the student behaviors
14. Helping to the group work
15. Having students come together for being able to teach cooperation
16. Finishing the lesson
17. Evaluation for students learning qualitatively and quantitatively
18. Evaluating the performance of the group
19. Forming academic contrasts.

iii. Teams-Game-Tournament (TGT)

Teams-Games-Tournament is one of the team learning strategies designed by Robert Slavin for review and mastery learning of material. Slavin has found that TGT increased basic skills, students' achievement, positive interactions between students, acceptance of mainstreamed classmates and self-esteem. In Team –Game-Tournament model the students play academic games as representative of their team. They compete with students having similar performance level and coach each other prior to the game to ensure all group members are competent in subject matter. Students earn team points based on how well they do at their tournament (Samaila, 2015). Hedeen (2003) opined that TGT method is different from the STAD method, in that the quiz and individual improvement scores are replaced with games and a 'tournament'.

iv. Group Investigation Model (GI)

Group Investigation model was developed by Sharan & Sharan (1992), which is a general classroom organization plan in which students work in small group using cooperative inquiry, group discussion and cooperative planning projects. In this model, students form their own two-to six member groups. After choosing sub-topics from a unit that the entire class is studying, the groups break their subtopics into individual tasks and carry- out the activities that are necessary to prepare group report. Each group then makes a presentation or display to communicate its findings to the entire class. The absolute freedom given to students to form their own group subjects this model to the danger of constituting a homogenous group where the students of equal ability may come together as a group. Exclusion of low ability students can easily manifest itself under this arrangement (Gumel, 2015).

v. Jigsaw Model

Jigsaw Model is a cooperative learning structure applicable to team assignment that call for expertise in several distinct areas. Students become “experts” on a concept and are responsible for the other group members. Groups subdivide a topic and members work together with those from other groups who have the same topic, they then return to their original group and explain their topic. According to Jansoon and Samsook (2008), Jigsaw method consists of two groups: a home group and an expert group. The lessons are divided into independent sub-lessons that are done in parallel. Each student becomes an expert in one sub-lesson as part of a group investigation. The groups select an interesting topic for investigation, and the students generate questions and then construct their

knowledge. The structure of knowledge is hierarchical, and each step can be studied separately and subsequently put together.

2.5 Jigsaw Cooperative Learning Strategy

Jig-saw is a type of cooperative learning strategy that is grounded in the belief that learning is most effective when students are actively involved in sharing ideas and work cooperatively to complete their academic task. A variety of jigsaw approaches have been developed each of which involves students teaching their peers. This method works best when topics are simple enough for students to teach it to their peers, but complex enough to warrant discussion and numerous strategies for instruction.

The following specific steps are followed by the teacher to form jigsaw group for each lesson.

1. Students are divided into 5 to 6-person jigsaw groups. Effort is made in making sure that the groups are diverse in terms of gender, ethnicity, race, and ability.
2. One student from each group is appointed as the group leader. His/her role is to coordinate the group discussion and maintain order. Other members of the group are assigned different roles. Example of such roles include time keeper who reminds group members of the time left for group work.
3. The days' lesson is then divided into 5-6 segments by the teacher corresponding to the member of the group.
4. One segment of the lesson is assigned to each student in a group to learn making sure that students have direct access only to their own segment.

5. Students are given time to read over their segment at least twice in order to become familiar with it. The teacher encourages the students not to memorize the segment given to them.
6. Temporary “expert groups” are formed. This was done by having one student from each JigsawIV group joined the other students assigned to the same segment. Students in these expert groups are given time to discuss the main points of their segment and to rehearse the presentations they would make to their jigsaw group members. The teacher goes round supporting the students.
7. Students are brought back to their JigsawIV (main) groups.
8. Each student who studied a particular segment is asked to present his or her segment to the rest of the group members. Other members of the group are encouraged to ask questions for clarification.
9. The teacher moved from group to group, observing the process.

Students first work in small groups to develop knowledge about a specific topic. They help each other become “experts” and formulate ways to teach the topic to other students.

Expert Group Discussion

Participants working on the same question in the expert sheet form an expert group. Four or five expert groups are thus formed. In order to facilitate the discussion, some guiding questions are set for each expert group. Each member is encouraged to take notes of what they discussed so that they can teach their members in their home group after the expert group discussion. Whenever a problem arises, the participants try to handle it by themselves before seeking help from the teacher. Conflicts resolved using appropriate social skills. Depending on the type of questions, group consensus may be necessary.

A A B B C C D D
A A B B C C D D

Figure 2.1 Students at Expert Group

Figure 2.1 shows four different groups of students with four members each. Members of these homogenous groups A, B C and D discuss their idea until all members become expert on the tasks assigned to them. For instance those in group A were assigned meaning of Hydrocarbon, those in group B were given classes of hydrocarbon, those in group C were assigned to learn about sources of hydrocarbon while those in group D were given the task of learning the uses of hydrocarbons. The student in each expert group would then come together to share idea, constructs and also discuss the content given to them until all members become expert. After these students have become competent on the topic from the expert group discussion, they are broken up into new "jigsaw" groups consisting of one student from each of the expert groups as explain below.

Jigsaw Groups (Home group reporting)

Participants in the expert groups would go back to their original home group to teach others the sections they have discussed. They would be reminded to help each other to master the materials as much as possible. After each member has shared his/her expert knowledge with each other, the teacher would conduct a short whole class discussion. The purpose of the class discussion is for clearing doubts, if any, as well as for provoking further discussion of the topic. This is only applicable to JigsawIV cooperative learning strategy. The other unique feature of JigsawIV Cooperative Learning Strategy is the re-teaching the major point and the missing part of the lesson after individual quiz.

A B A B A B A B
C D C D C D C D

Figure 2.2 Students at Home Group

The above is an illustration of the home groups otherwise known as Jigsaw groups, where members of different groups with different contents and tasks come together to explain to the other members. Student from group A would explain the meaning of Hydrocarbon, student of group B would show an expertise and explain the classes of hydrocarbon, that of group C explained the sources of hydrocarbon, finally that of group D would come forward to explain the uses of hydrocarbons to other group members. At this stage other members of the group were encouraged to ask questions for clarification.

There are currently six types of Jigsaw cooperative learning strategies available for teachers to use in the classroom (Jansoon & Samsook, 2008, Johnson, & Johnson, 2009). They are:

I. Jigsaw I (Aronson,1978)

II. Jigsaw II (Slavin, 1986)

III. Jigsaw III (Stah,(Ed) 1994).

IV. Jigsaw IV (Holliday, 2002)

V. Reversed Jigsaw (Hedeen, 2003)

VI. The Subject Jigsaw (Doymus, 2007)

Jigsaw I

The original Jigsaw method was developed by Aronson and colleagues in 1978, and its mode of operation is now explained in more detail. The method essentially consists of breaking down a large topic into a number of small topics, with the production of an ‘expert sheet’ prepared by the teacher. The students work in a ‘home group’ which is

heterogeneous in nature. They are each assigned to read an expert sheet, and then those who have the same expert sheet move from the home group to a separate expert group in which they then discuss their topic in detail. Once the discussion in the new group is complete, they return to their home group, and teach all their home group members about the topic that they are now expert in. Finally, the groups are assessed, and individual grades are given.

The Jigsaw II

Jigsaw(II) method was modified from the original method by Slavin in 1986. Aronson and Patnoe (1997) reported that Jigsaw II has two substantial changes: all students in the team read all the lessons, and the scores of students are combined to contribute to an overall team score. This method has been used for subjects in the Social Sciences, and particularly when the learning goals focus on concepts rather than skills (Slavin, 1990). The implementation of Jigsaw II comprises five steps Chan, (2004): (1) reading; (2) expert group discussion; (3) home group reporting; (4) testing; and (5) group recognition (ie team competition is allowed in Jigsaw II).

The Jigsaw III

In the case of Jigsaw III, Gonzalez and Guerrero (1987) modified Jigsaw II to increase the interaction between students. Stahl (1994) note that Jigsaw III has the addition of a cooperative test review process. This cooperative test review involves reconvening the home group and reviewing the process.

The Jigsaw IV

Finally, Jigsaw IV, developed by Holliday (2002), includes three important new features: an introduction, quizzes, and re-teaching after individual assessment (Holliday, 2000). In

order to stimulate student interest in the lesson, the teacher first introduces the lesson by means of lectures, presentation of literature, questioning, proposing problems, or perhaps showing a movie in a 'plenary' class session. Students are then assigned to a heterogeneous group – the home group – and all students are assigned topics to read. Here each student discusses the expert sheet that is based on a list of all topics. Again, the students with the same expert sheet move to their expert group to discuss their topic. In order to check accuracy and understanding of students in the expert group, they are assessed by means of a quiz – this being based on the expert sheet. They return to their home group, teach all their group members and take quizzes all based on the original material. The teacher reviews and clarifies any concepts which it appears the students did not understand. The students take individual quizzes, and scores are combined to produce an overall team score. Finally, the teacher re-teaches any material which was misunderstood after the individual assessment process.

Table 2.1 Comparison of Jigsaw, Jigsaw II, Jigsaw III, and Jigsaw IV (after Holliday, 2000)

s/no	Jigsaw	Jigsaw II	Jigsaw III	Jigsaw IV
1	-	-	-	Introduction
2	Expert assign to expert group	Same as Jigsaw I	Same as Jigsaw I	Same as Jigsaw I
3	Member answer expert question	Same as Jigsaw I	Same as Jigsaw I	Same as Jigsaw I
4	-	-	-	Quiz
5	Members returned to home group and information	Same as Jigsaw I	Same as Jigsaw I	Same as Jigsaw I
6	-	-	-	Quiz
7	-	-	Review process	Same as Jigsaw III
8		Individual assessment	Same as Jigsaw II	Same as Jigsaw I
9	-	-	-	Re-teaching

Adopted from Jansoon, Samsook & Coll (2008)

According to Holliday (2000), the three important features of Jigsaw IV are the introduction, the quiz, and re-teaching:

1. **Introduction:** The teacher introduces the lesson by means of lectures, literature, questions, and problems. The purpose here is to stimulate student interest in the lesson;
2. **Quiz:** The students are evaluated by means of two quizzes:

i. The first quiz is designed to check the accuracy and understanding of student in the expert group - this based on the expert sheet.

ii. The second quiz is designed to check accuracy and understanding of students in the home group - this based on all original material; and

3. **Re-teach:** The teacher re-teaches the material which they think has been misunderstood based on the individual assessment process.

Holliday (2002) goes on to say that class activities can be sorted into nine processes.

a. **Introduction.** The teacher introduces the principle and experiment to the students in a plenary session, and assigns students to a home group, containing six students. The members of each home group are divided into expert groups;

b. **Expert sheets assigned to expert groups;**

c. **Answer expert questions prior to returning to home group.** The students are asked questions based on their expert sheet to check their understanding prior to returning to their home group;

d. **Quiz on material in the expert groups checking for accuracy.** The teacher administers quizzes to assess the validity of their responses;

e. **Return to home groups to share their information with their group.** The students return to their home group to teach their peers, and to share information with each other in their home group;

f. **Quiz on material shared, checking for accuracy**. The students are asked questions based on all original material;

g. **Review process.** The teacher reviews and clarifies any concepts which the students did not understand;

h. **Individual assessment and grade.** Each student is reassessed using a post-test; and
i. **Re-teach.** The teacher re-teaches any topics found to be difficult based on the post-test assessment.

In this study the Jigsaw IV Cooperative Learning Strategy was employed as treatment for the experimental group to see its effects on students' perception, retention and academic performance in Zaria Education zone, Kaduna, Nigeria.

The Reverse Jigsaw

This is one of the newest methods created by Hedeen (2003) under the cooperative learning techniques used in classroom settings. It follows the same principle as the original Jigsaw method. The jigsaw technique in the cooperative learning methods uses a small group structure to facilitate group discussion through which the learning takes place. The reverse jigsaw method also resembles the original jigsaw method in some way but has its own objectives to be fulfilled. While the jigsaw method focuses on the student's comprehension of the Instructor's material, the reverse jigsaw method focuses on the participant's interpretations such as perceptions, judgments through a very active discussion. This method was mainly created to cater for the higher class students. It is best advised to give an explanation before the discussion of the topics takes place. This does not only ensures that the learners are more effective in their discussion but also saves time. It differs from the original Jigsaw during the teaching portion of the activity. In the Reverse Jigsaw technique, students in the expert groups teach the whole class rather than return to their home groups to teach the content (Heeden, 2003).

Process of Reverse Jigsaw

The process involved in the reverse Jigsaw method can be explained in 3 steps according to Heeden, (2003);

1. Students gather in mixed groups where they are each given a case study with a number of questions or one complex question and allotted time of about 15 mins to discuss. Each member of the team is given a unique topic and hence a discussion is initiated within the mixed group and the main points and outcomes are noted.
2. Each member is gathered in the expert group or topic group and the points and outcomes are compared. A report is prepared compiling all the common and divergent themes. The time allotted for this could be between 15 - 20 mins. A reporter is appointed to present the same before the class.
3. The class gathers as a whole and the reporters from the individual topic group present their reports to the whole class by ways of overheads, flipcharts or chalk board, following which the instructor debriefs the whole exercise with review or evaluation of the process.

Requirements and Limitations of Reverse Jigsaw

Hedeen (2003) identifies the following requirement and limitation of reverse Jigsaw

i. This method can be only applied to undergraduates, graduates and other professional training groups.
ii. It is best preferred for students to form groups where they can face each other while discussing.
iii. In case the classroom has immovable furniture, the instructor can opt to send the groups out for discussion and can give a time limit to assemble back in the classroom for the next part of the exercise.

In summary, in all of the Jigsaw methods, students are assigned to study specific topics in an expert group, they become the expert on their topic, and subsequently they teach all their home group members. This means they have the opportunity to teach and learn in their groups, they are able to share their ideas; they develop their self-confidence, cooperation, motivation and perceptions (Barbosa, Jofili, & Watts, 2004). In other words, the students are able to improve in both cognitive and affective ways (Eilks, 2005). As noted earlier, the Jigsaw methods are used in science classes more than other collaborative learning methods, because the structure of much science knowledge is hierarchical, meaning each step can be studied separately and then put together – like a jigsaw! (Jansoon & Samsook, 2008). This study adopted the use of Jigsaw IV Cooperative Learning Strategy because it includes three new features: an introduction, quizzes, and re-teaching of material after individual assessment which makes it better than Jigsaw I, II and III and other type of Jigsaw (Johnson, & Johnson, 2009). In view of this, this study investigates the effects of Jigsaw IV Cooperative Learning Strategy on secondary school students' perception, retention and achievement in Organic Chemistry in Zaria Educational Zone, Kaduna, Nigeria.

2.6 JigsawIV Cooperative Learning and Perception in Science Education

Many authors have expressed different opinions for the term perception. Mukherjee, (2002) opined that perception implies the psychological process occurring in the brains of the organism leading to the organization and interpretation of sensory information received from the stimulus or stimuli. Perception mechanisms include analysis, synthesis and integration of sensory information. When several individuals confront an object or

thing in their environment, the input of information that impinges on their respective sense organs, (eyes, ears and so on) is the same for every individual, though they perceive differently. According to Idris, (2011), perception is that which affects and responds to each other. It considers how attitudes are shaped by parents and peers, how people perceive, evaluate others and how human beings influence each other as they interact. Thus, perception is a process through which man continues to interact with environment, thereby, experiencing a form of strong base of knowledge that built up an individual.

Omuya, (2002) reported that one of the pioneer scholars to examine the facts of perception in some detail was Descartes, in Shafiu, (2014). He explained that Descartes explanation formed the basis of all major theories of perception in the seventeenth century. Descartes maintained in his theory of perception that the organs of sense and nerves connecting to the brain, the brain itself, and the messages from the brain to various muscles were responsible in a part to visual perception. Perception is a dynamic process of sensory data to produce perceptional objects and events. It satisfies a number of factors which influence what and how a person perceives. Individual perceptions are influenced by the way human bodies are structured to receive and process stimuli from the environment.

The body of every human being is made up of sensory system each of which contains organs such as eyes that are used for vision; ears for hearing, skin for touching and general protection of the whole systems. Each organ has its specialized parts and functions. These parts are called receptors that change energies from environment into nerve impulse. For instance, in the eye there is a sensitive structure known as retina that possesses two different types of receptors rodes and cones. The rodes, response to light

and allows us to see in dimly light environment, while cones responds to different frequencies of light and equally assist in detecting colour (Omuya, (2002). From these view points, the particular way by which every receptor is structured and functions helps to determine the perceptual effects related to them. Idris, (2011) is of the view that perception is the translation of the raw data from the senses into meaning by the brain. So the brain can interpret the situation according to its condition. It is also one of the means by which we select, organize, and interpret acquired evidences from our senses.

Many psychologists have approached the theory of perception from different angles. According to Piaget in Shafiu,(2014) perception is one of the most important processes of cognitive development and that light waves stimulate the eyes retina and messages about the stimulus are carried along the optic nerve and processed by the visual cortex in the brain. But man does not always perceive the same visual stimulus in the same way. From Piagets views therefore, it can be inferred that teachers as well as students need to be made aware that perception is a very important process of cognition in every individual but difference occur in the way individual perceive and interprets information.

Burner, (1960), defined perception as the process by which individuals extract meaningful information from the physical stimulation and the way the sensation is interpreted. He further made three important points about perception:

i. Perception is always determined by the perceiving individuals experience, intention and social needs.
ii. Perception is one who actively selects information and form perceptual hypotheses in order to reduce uncertainty and decide what precisely is happening
iii. Perception is an activity that is fundamentally of the same nature as concept

attainment and the other higher mental process.

Furthermore, he went on to say that experience plays a vital role in perception. He also supported Piagets position that individual differs in the way and manner people perceive and in their interpretation that is consistent with the idea that every child is educable (Burner, 1960).

Mustapha (2001) conducted a study on lecturers' perception of integrated science. Eighty four integrated science lecturers' were randomly selected from 17 Colleges of Education that offered Integrated Science double major course. A 34-item researcher design questionnaire which is an adaptation of 3 – point Likert Scale was administered to respondents. Mean, Standard Deviation and Variance Statistics were used to analyze this data collected. Findings showed that lecturers have positive perception of integrated science curriculum. Teacher's professional qualification area of specialization and in-service training also influenced their perception of integrated science concepts.

Similarly, Jimoh, (2006) on his own identified topics perceived difficult by Chemistry students in Nigerian secondary schools. Five hundred and sixty SS III Chemistry students were randomly selected from 28 senior secondary schools in seven states of the federation. A 20 – Item questionnaire was administered to respondents. Mean, standard deviation, variance and t-test statistics were used to analyze research data collected. Findings showed that Chemistry students perceived 13 topics (65%) difficult to comprehend, Organic Chemistry inclusive. The study also revealed that students' gender and school location have no influence on their perception of difficult topics in Chemistry curriculum, while school nature influenced perception of Chemistry topics.

Furthermore, Jansoon, Samsook and Coll (2008) examined students' perceptions of their learning of dilution Chemistry via the Jigsaw IV approach in practical class at Thai University, Thailand. They observed that, as the students worked together in groups, and employed more interactive learning strategies, in particular, each student became an 'expert' for a specific topic, and subsequently taught his or her home group. As such they gained positive perception/self-confidence and understanding of the concepts after completing the experiments.

However, for science students (Chemistry) to have positive perception of science concepts that would enable him/her to direct the learning through application of the principles in real life situation, thereby enhancing both performance and retention of such concepts, they need to be active creator of their knowledge through hand-to-hand manipulation, cooperative interaction as seen in JigsawIV Cooperative Learning Strategy is required. From the study reviewed so far, there is little attempt to investigate the effectiveness of JigsawIV cooperative learning strategy on students' perception in Nigerian context. This study therefore, examined the effects of Jigsaw (IV) Cooperative Learning Strategy on students' perception in Organic Chemistry concepts among the SS II Students of Zaria Educational zone.

2.7 JigsawIV Cooperative Learning and Retention in Science Education

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), also 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) anything that improves meaningful learning improves retention while things that lead to confusion or interference among learned materials, decrease the speed and efficiency of learning and accelerates forgetting. Retention, in other words, is the continued existence of what has been.

Lakpini, (2006) on the other hand, explained that retention has to do with memory, that the memory stores information or activities learnt and the storage could be in form of sensory, short term or long term. It was further explained that messages received through sensory memory using one or more of the sense organs are not easily recalled, unless they are stored in the short term memory. Also, that short term memory last only for about 20 seconds and has the capacity to hold only about seven separate pieces of information at a time. The long-term memory however, they opined is a relatively permanent store house of knowledge which has the capacity to store enormous amount of information for over a long period of time even as long as a life time. Information stored in the long term memory can be described as information retained. Attah (2014), posits that retention is higher when the degree of original leaning is high. In other words, any teaching method that would lead to effective learning would also lead to higher retention. In pedagogical consideration, it is a rule of thumb that being a genius in ones field of study does not necessarily predict that one would be a good teacher. What makes a good teacher is the

ease with which one is able to impart knowledge to the leaner or bring about a change in the behaviour of the learner. For a student to remember what was taught for a long period can be an assessment of how well he or she was taught, so students poor achievement in Chemistry can be said to be as a result of their low retention of what was learnt.

In promoting greater performance, several studies reported that Jigsaw cooperative learning also fosters greater retention of learning, as indicated by students' results on delayed achievement tests (Sousa, 2006; Moore, 2008). For example, Sousa (2006) reported the average percentage of learning material retention after 24 hours when students were taught by different teaching methods. He indicated that there is retention of 50% of material learned in the discussion group, 75% as a result of requests for students to study through practice, and 90% when students teach others. In addition, Moore (2008) reported studies showing that a blend of *'telling'* and *'showing'* techniques results in greater retention (65%) after three days. It is therefore argued that the best way to learn something effectively is to prepare to teach it. In other words, whoever explains learns (Sousa, 2006). Teaching others and elaborating ideas are the main features of Jigsaw cooperative learning (Kagan & Kagan, 2009; Slavin, 2011). The consistent elaboration of learning concepts provides students who either receive the explanation or those who give the explanation with a deep understanding and a more complete retention of the concepts being learnt for a longer period of time (Chianson, Kurumeh & Obida, 2010). Consequently, as shown in the above review, in Jigsaw cooperative situations, students retain more knowledge when they offer more explanation and elaboration to others (Zakaria, Chin, & Daud, 2010; Webb, 2008).

Similarly, studies have also reported the effects of different forms of pedagogy on retention of learning particularly jigsaw cooperative strategy. For example, an impressive study lasting 4 weeks was conducted by Tanel and Erol (2008) in which the effectiveness of the jigsaw learning method and conventional teaching method were compared on achievement and retention in a Physics course in University in Turkey. An experimental group received the jigsaw technique and a control group received traditional teaching. Results from the t-tests indicated that there were significant differences ($p < .001$) on the Postpost test scores. The experimental students had greater achievement and long-term achievement than those in the control group. An inspection of post-test scores and Postpost test scores for each group shows that four weeks after the experiment the students in the experimental group retained nearly 98% of their knowledge on the delay test whereas those in the control group retained nearly 80percent.

Sahin (2010), also used a pre-test and post-test design to investigate the effects of Jigsaw III on achievement, and retention, of 71 Turkish sixth-grade students in a Turkish course over a 6-week period. The post-test was administered at the end of the treatment, while the delay test was administered 6 weeks after the treatment. The results from the t-tests indicated that students in the jigsaw group outscored the achievement test of those in the traditional lecture-based learning group. The jigsaw group also had greater long-term achievement on the delay test ($p < .05$) than those in the control group. However, an inspection of post-test and delay test scores for each group shows that six weeks after the experiment students in both groups had a similar percentage of knowledge retention (approximately 79 percent of their post test achievement).

Souvignier and Kronenberger (2007) also reported the effectiveness of jigsaw learning on mathematics and science achievement, and knowledge retention of 208 third-grade students in Germany. A strong relationship between Jigsaw cooperative learning methods and higher achievement as well as greater long-term achievement shown in the literature supports the hypothesis that in general (Souvignier & Kronenberger, 2007). Students who are taught by JigsawIV Cooperative Learning Strategy have greater retention of information taught in the organic Chemistry concepts than those taught through lecture-based teaching. In view of this, this study examines the effects of JigsawIV Cooperative Learning Strategy on students' Zaria Educational Zone, Kaduna, Nigeria.

2.8 Jigsaw IV Cooperative Learning and Academic Performance in Science Education

Academic performance is an important educational variable that expresses the success or failure of a teaching and learning process. The success of a course in any subject is a measure of its academic achievement. Academic performance generally means proficiency in a given skill or body of knowledge. There are several views expressed on academic performance. Idris (2011) sees academic performance as the display of knowledge attained or skills developed in school subject designed by test and examination scores or marks awarded by the subject teacher.

Similarly, Bitrus, (2012) opined that, academic performance as a measure of student learning outcomes at the end of teaching/learning activities can be assessed by outcomes and improvement in the performance resulting from education. Aniaku (2013) referred to academic performance as the scholastic standing of a student at a given moment which

states the individual's intellectual abilities, which can be measured by grades obtained from examinations or continuous assessments (tests or quiz).

In Nigeria, the level of students' academic performance in the senior secondary school is determined by grades obtained from external senior school certificate examination conducted by examination bodies like WAEC and NECO respectively. The pattern of grading candidates score in the examinations is such that distinction grades were represented by A_1-A_3, credit grade C_4-C_6, ordinary pass grades D_7-D_8 and failure grade, F9 (Attah, 2014).

Researchers like Lakpini, (2006): Lawal, (2009): Ihejirika, (2010) and Gumel (2015) observed that the issue of poor academic performance is still prevalent in Nigerian secondary schools. This has been attributed to so many factors among which is the difficulty of science subjects as a results of constant use of teacher centered method, (Lakpini, 2012 and Ibrahim, 2013). This is why science educators advocate for the use of innovative teaching/learning strategy that would curtail the mass failure of students in science subjects and Chemistry in particular. One of these innovative learning strategies is jigsaw cooperative learning strategy.

Several studies show that Jigsaw Cooperative Learning Strategy is a learning strategy that enhances students understanding and academic performance of sciences. Hanze and Berger, (2007); Doymus, (2008); Jansoon, Somsook and Coll, (2008); Berger and Hanze, (2009); Keramati, (2010); Gambari, (2010); Gambari, Olumorin and Yusuf (2012); Timaye, etal (2015) and Gume, (2015), found that students' performance improved after instruction using Jigsaw Cooperative learning strategy. Specifically, the empirical studies by Hanze and Berger, (2007); Berger and Hanze, (2009); and Keramati, (2010); found

out that the students acquired knowledge of Physics concept easier and understood the concepts better when taught with JigsawIV Cooperative Learning Strategy. Timaye, etal (2015) in another study determined the effects of JigsawIV Cooperative Learning Strategy on academic performance of secondary school students in Geometry towards the subject. The results showed that the students' performance in Geometry improved after the instructions using JigsawIV Cooperative Learning Strategy. Studies by Doymus, (2007) and Jansoon, Somsook and Coll, (2008), on academic performance of secondary school students in Chemistry showed that JigsawIV Cooperative Learning Strategy enhances students' performance in chemical equilibrium and practical chemistry respectively. They specifically emphasized that JigsawIV Cooperative Learning Strategy make Chemistry knowledge long lasting and that students become more capable of applying their knowledge in other areas outside the original context. There appears to be scarcity of literature on the effect of JigsawIV Cooperative Learning Strategy on retention and perception when separated from performance as a whole.

Egitim and Bilim (2013) in their research on enhancing students' performance in Chemical nomenclature through the Jigsaw Cooperative Learning Strategy, observed that Jigsaw Cooperative Learning Strategy enhances students' performance in nomenclature of chemical compounds and it also favors both boys and girls, giving credence to the Jigsaw model as a gender sensitive approach. Although, Seaborn and Wilson (2002), and Shaaban (2006), found no significant difference in the achievement of students taught using Jigsaw II and those taught using conventional classroom and discussion methods respectively. However, from observation so far, no much effort has been made on how the JigsawIV Cooperative Learning Strategy can enhance students' retention and

perception among secondary school students in Organic Chemistry. In the light of this, the study determined how JigsawIV Cooperative Learning Strategy influences students' perception, retention and academic performance in Organic Chemistry in Zaria Educational Zone.

2.9 Gender and Students' Performance in Science

Gender as stated earlier is a social term that is set to differentiate males and females in terms of their different roles and responsibilities. Gender appears more often in recent science education researches. This may be in attempt to find ways of closing the gap between the participation rates of the two sexes in Science Education. Eze (2008) is of the opinion that gender issue is a pertinent factor in educational setting in Nigeria and could be a factor that leads to low performance of learners in Chemistry as a science subject. It has also been observed that there is a narrow participation of females in science and technology courses as well as the number holding professional career in science and technology. Eze (2008) pointed out that a number of alternative explanations have been proposed for the gender inequalities in science and technology. Such explanations among other things include:

i. Biological determinism: This explanation proposes that an inequality in science and technology is sex-linked. It is a biological inheritance. This states that spatial ability is sex-linked in favour of males while verbal expression is sex- linked in favour of females. This claim is debunked by Okeke (2011) who proved that statistics on ground has shown that so far there is no biological evidence that males have intrinsic superior intellectual abilities over females.

ii. School Type: This factor examines single sex school type versus coeducational type. It is argued that the type of school females attend directly influence their interest and performance in science subjects. This argument initially tilted in favour of girls in single sex schools as being more advantaged in science than females in co-educational schools. Okeke (2011) claims that the praise showered on single sex schools for their education of females is not particularly related to the fact that they are single sex school, which one exposed them to better learning conditions should also be considered. In Nigeria for instance, most unity schools are federal government schools which attract females from upper class background (children from rich parents) and may be the student's characteristic of good home background that is responsible for their fostered enrolment and performance in science in single sex schools and not because they are single sex. Attah (2014) therefore concluded that the issue of single sex school fostering enrolment and performance of girls is being challenged. Further research is then needed to settle their debate. That is why JigsawIV Cooperative Learning Strategy was used in co-educational Senior Secondary Schools in Zaria Educational zone to see whether gender disparity can be minimized.

iii. Teacher Influence: Teacher influence can be observed on the gender of the science teacher, the expectations of the teacher and the classroom interaction of the science teacher with the students is also important. There is a preponderance of male science teacher in most parts of the world including Nigeria thereby making science appear masculine. Observation shows that culture has a lot to play in this imbalance in most parts of Nigeria. People initially looked down on the education of females and females

have to go to school first before they can decide whether to go for science subjects or not. But with more females in school, more female science teachers are coming on.

Despite the fact that gender has been identified as one of the factors influencing students' performance in sciences at senior secondary school level. However, Olson (2002) reported that females performed better than males students when taught mathematics using cooperative learning. Contrarily, Khairulanuar, Nazre, Sairabanu, and Norasikin (2010) found gender differences in favour of male students. On the other hand, Annetta, Mangrum, Holmes, Collazo and Cheng (2009), Kost, Pollock and Finkelstein (2009), Adeyemi (2008) and Ajaja & Eravwoke (2010) reported that gender had no effect on academic performance of students in Jigsaw cooperative learning strategy. These contradictory findings have called for inclusion of gender as one of the moderating variable for this study.

The reviews show the inconclusiveness of the findings on jigsaw cooperative learning on gender and perception of the learners. Furthermore, previous studies focused on comparative effects of jigsaw cooperative learning strategy and conventional classroom instruction in other aspect of Chemistry, without examining the effectiveness of Jigsaw IV Cooperative Learning setting in Organic Chemistry. Based on these facts the present study examined the effects of Jigsaw IV Cooperative Learning Strategy on Students perception, retention and performances in Organic Chemistry concepts, in Zaria Educational Zone.

2.10 Overview of Similar Studies

This study iss titled “effects of Jigsaw IV Cooperative Learning Strategy on Secondary School students’ Perceptions, Retention and Performance in Organic Chemistry in Zaria, Kaduna State, Nigeria”. Various empirical studies and researches have been conducted in this country such as that of Yusuf, (2005); Gambari, Olumorin and Yusuf (2015); Mari and Gumel (2015); Timaye *etal* (2015) and elsewhere in the world such as that of Doymus, (2007); Jansoon, Samsook and Coll (2008); Abdullah (2010); Egitim and Bilim (2013); Gülşen and Demircioğlu (2013); Naomi and Githua (2013); Esin and Ali, (2016), which are either directly or indirectly related to this study. The researcher looks at some of these studies one after the other.

Yusuf, (2005) investigated the effects of Jigsaw collaborative learning on Chemistry students’ Academic Performance and Anxiety level in Balancing Chemical Equations in secondary schools in Katsina State. The study sampled out 80 SS II students from two senior secondary Schools in Katsina metropolis. Both experimental and control group were made up of 40 students each. Quasi-experimental research design was used for the study. The students in the experimental group were taught using Jigsaw collaborative learning strategy while those in the control group were exposed to traditional method. The instrument used for data collection was Chemistry Performance Test and Anxiety Scale Questionnaire. t-test statistical tools for unrelated sample at a significance level of 0.05 was used to test the null hypotheses. The finding of the studies revealed that those taught using Jigsaw Collaborative learning performed significantly higher with low Anxiety level than those exposed to lecture method of teaching. The study is similar to the present study in that, both studies used Jig-saw model and adopted quasi-

experimental design. However, the studies differ in terms of sample size, number of null hypotheses as well as the location and subject area. While the former study was conducted in Katsina state (2005) with focus on chemical equation, the present study was carried out at Zaria Education zone, Kaduna state, with emphasis on Organic Chemistry, as a concept taught in senior secondary schools Chemistry.

Doymus (2007) investigates the effect of cooperative learning (Jigsaw) versus Individual Learning Methods on Students' Understanding of Chemical Equilibrium in a First-year General Chemistry Course, Ataturk University, Erzurum, Turkey. True experimental design was used, where two different classes in the department of Primary Science Education during the 2005–2006 academic years at Ataturk University, Erzurum, Turkey were used. One of the classes was randomly assigned as the non-jigsaw group (control, n=36) and other as the jigsaw group (experimental, n=32) using simple random sampling with the sample size of 68 students. The main data collection tool was a Chemical Equilibrium Achievement Test (CEAT), which was applied to both the jigsaw and non-jigsaw groups and t-test statistical tools was used in testing null hypothesis. The results indicated that the jigsaw group was more successful than the non-jigsaw group (individual learning method). The study is similar to the present in that, both studies adopted Jigsaw model in the teaching of experimental group. However, the studies differ in term of research design, sample size, location and concepts taught. Unlike the present study which used quasi-experimental design, and was conducted among SS II students in Zaria, Kaduna State, Nigeria with emphasis on organic chemistry concepts. The former study adopted true experimental design and was carried out in Ataturk University, Turkey among undergraduate students with emphasis on Chemical Equilibrium.

Jansoon, Samsook and Coll (2008) investigated the effectiveness of Jigsaw IV Method on Students' Learning Experiences in Thai chemistry Laboratories, Thai University. A hands-on experiment based on the Jigsaw IV method using a real life example based on green tea beverage was designed to improve student affective variables for studying topics related to dilution. The study adopted true experimental design. The sample consisted of 244 first-year students enrolled in the usual first year Chemistry Laboratory course in the science faculty at a prestigious Thai University. A simple percentage was used in computing the students' attitudes to learning dilution topics. The research findings, based on self-completion questionnaires and classroom observations suggest that in the past these students did not particularly enjoy learning in Chemistry practical classes, and they reported using highly formulaic approaches to solve Chemistry problems for dilution. In contrast they enjoyed the more interactive nature of the Jigsaw IV approach, and in particular acting as an 'expert' in front of their peers, which enhanced their self-confidence about chemistry learning in practical classes. The study is similar to the present one in that, both studies used JigsawIV Cooperative Learning Strategy in the teaching of the experimental group. Though the two studies differ in terms of research design, level, location and concepts taught. Unlike the former study which used true experimental research design and was conducted on Thai University students, with focused on dilution Chemistry in Thai Laboratories, while the present study used quasi-experimental research design and was conducted on SS II student of Zaria Education Zone, Kaduna, Nigeria with emphasis in Organic Chemistry.

Abdullah (2010) investigated the effects of a cooperative technique Jigsaw II (experimental group, n=42) and instructional teacher-centered teaching method (control

group, n=38) on Turkish Language Teacher Education Department students' attitudes to written expression course (a course in which writing skills were taught), their academic achievement, retention and their views, in 2009 to 2010 academic year. In this research "pre-test/post-test with control group experimental design" was used. The data was collected through Attitudes to Written Expression Scale (ATWES) and Written Expression Achievement Test (WEAT), Students' View Form (SVF). The t-test and simple percentage statistical analyses revealed that there were significant differences between the experimental and control groups in terms of their attitudes, academic achievement, and retention in favor of the experimental group. In addition, It was determined that the experimental group students had positive views on the use of Jigsaw II technique. The study is similar to the present one in that, both studies determined the effects of Jigsaw model on academic performance and retention of students. However, the studies differ in that; the present studies used JigsawIV Cooperative Learning Strategy, while the former study adopted the used of Jigsaw II Cooperative learning strategy. The present study was carried out at Zaria, Kaduna with focused in Organic Chemistry while the former study was carried out on Turkish language teacher education students, with emphasis on Turkish Language.

Gülşen and Demircioğlu (2013) investigated the effect of the jigsaw cooperation learning technique on students understanding and alternative conceptions concerning basic Organic Chemistry concepts in Trabzon, Turkey. The study was conducted with a total of 52, 9th grade students in a high school in Trabzon. Quasi-experimental design (an experimental group and a control group) was used. While experimental group students performed activities based on the jigsaw technique, control group students were taught

with the traditional approach. The treatment lasted for three lessons of two hours in both groups. An Organic Chemistry Performance Test (OCPT) involving 5 open-ended questions was used to collect data. The data obtained from pre-and post –tests of both groups were compared with the independent t-test statistical tools at $P \leq 0.05$ level of significance. The post –test results showed that there was a significant difference between groups in favor of the experimental group. In other words, the experimental group students taught with the jigsaw technique performed better in the post-test than the control group. The study is similar to the present one in that; both studies used jigsaw model with emphasis on pretest, post test experimental and control groups. However the two studies differ in terms of type of Jigsaw, location and statistical tools used. While the former study used Jigsaw I Cooperative Learning Strategy and was conducted in Trabzon (2013), the present study used Jigsaw IV Cooperative Learning Strategy and was carried out in Zaria, Kaduna, Nigeria with both emphases on Chemistry as a subject in secondary schools. Though, the study used t-test statistical tools as inferential statistics to test the null hypotheses, the present study used ANCOVA, Kruscal Wallis and t-test statistical tool at $P \leq 0.05$ level of significance, in analyzing the parametric and nonparametric data collected. The gaps filled was perception, gender related issues and retention ability of Chemistry students after exposure to Jigsaw IV Cooperative Learning Strategy

Naomi and Githua (2013), conducted a study on the possible effects of jigsaw cooperative learning strategy on students' achievement in secondary school Mathematics in Laikipia east district, Kenya. Solomon four non-equivalent control group research designs were used in the study which is a form of quasi-experimental design. A simple random sample of four co-education senior secondary schools made up of two

experimental groups and two control groups were selected from Laikipia East District. The sample size was 160 students out of a population of about 20,000 students in the district. The two experimental groups received the Jigsaw cooperative learning Strategy as treatment and two control groups were taught using the conventional learning/teaching methods. A Mathematics Achievement Test (MAT) was used for data collection. The instrument was validated and had reliability coefficient of 0.87. The statistical method of Analysis of Variance (ANOVA) was used to test hypotheses at 0.05 significance level. Findings of the study showed that learners taught using Jigsaw cooperative learning strategy performed better than those taught using Conventional learning methods. The study is similar to the present one. However, the major difference is the location, subject area and statistical tools used in analyzing the data. The study was conducted at Laikipia (2013) at Kenya in Mathematics as the subject area, while the present study was conducted at Zaria, Kaduna, Nigeria with emphasis on Chemistry as a subject taught in Senior Secondary Schools.

Gambari, Olumorin and Yusuf (2015) investigated the effectiveness of computer-supported jigsaw II cooperative learning strategies on the performance of senior secondary students in physics. The study also determined how moderating variables of gender and attitude to physics when Jigsaw II cooperative learning is used as an instructional strategy. Purposive sampling technique was used to select two senior secondary school class II physics students from four intact classes in Mina, Niger State, Nigeria. 80 students from two intact classes were assigned into Jigsaw II and Individualized Computer Instruction (ICI) groups. Computer-Assisted Learning Package (CALP) on physics and Physics Achievement Test (PAT) were used as treatment and test

instruments. Analysis of Covariance and Scheffe's test were used for data analysis. Findings indicated that students taught Physics using computer-supported Jigsaw II performed better than those taught using individualized computer instruction. In addition, students exposed to Jigsaw II cooperative learning strategy had positive attitude to Physics than those taught with ICI. However, students' gender had no influence on their performance. This study differ from the present one in that; the study adopted the use of Computer assisted Jigsaw II cooperative learning strategy on students' performance in Physics, while the present study determined the effectiveness of JigsawIV cooperative learning strategy on students' perception, retention and achievement in Organic Chemistry. The study was conducted at Mina, Niger State of Nigeria, while the present study was carried out at Zaria, Kaduna, Nigeria. However, the study used purposive random sampling in selecting the sample schools used whereas, the present study used simple random sampling to select two coeducational schools that were served as sample schools.

Mari and Gumel (2015) investigated the effects of jigsaw cooperative learning strategy on students self-efficacy and performance in Chemistry. In their study, they compared the academic performance and self-efficacy of concrete and formal reasoners exposed to the cooperative strategy and those exposed to the traditional method. Two groups of students were randomly selected for the study. One group was exposed to the jigsaw model of cooperative learning (the experimental group) while the other group was exposed to the traditional method (the control group).Variables investigated were the effects of the strategy on academic performance and the self –efficacy of formal and concrete reasoners. t-test statistics was used to analyze the data at the 0.05 level of significance.

Result obtained revealed that, the use of cooperative learning strategy has significant effects on the academic performance of formal reasoners more than that of the concrete reasoners. The study is similar to the present in that, both studies used Jigsaw model and organic Chemistry concepts in the treatment groups. However, the study differs, Mari and Gumel adopted the use of Jigsaw I Cooperative Learning Strategy while the present study investigated the effects of JigsawIV Cooperative Learning Strategy on students' performance and retention. The study used t-test statistics in analyzing the null hypotheses, while the present study used ANCOVA and t-test as well as Kruscal Wallis' statistics at $P \leq 0.05$ level of significance to test the null hypotheses. The study was carried out on N.C.E students in Jigawa State while the present study used SSII students of Zaria Education zone, Kaduna.

Timayi *et al*, (2015) investigate the "Effects of Jigsaw IV Cooperative Learning Strategy (J4CLS) on Academic Performance of Secondary School Students in Geometry". The quasi experimental research design involving a pretest and posttest was used. The population of the study comprised of 4624 senior secondary school year two (SS2) students of the public secondary schools in Zaria Educational Zone. Two coeducation schools were selected by the simple random sampling as the schools sampled for the study. The sampled students for the study comprised of 144 students from two schools from intact classes (Experimental = 72 and Control = 72). The Geometry Performance Test (GPT) was used as instrument for collecting data. The null hypotheses were analyzed by the t-test statistics statistical tools at $P \leq 0.05$ level of significance with the aid of the Statistical Packages for Social Sciences (SPSS version 21). The study revealed a significant difference in performance in favour of students exposed to the Jigsaw IV

Cooperative Learning Strategy. This study is similar to the present study in terms of main research variable been Jigsaw IV Cooperative Learning Strategy, the research design being quasi-experimental design, location (Zaria educational zone, Nigeria). However, the present study differs from the former only in terms of statiscal tools used and the subject area. The used t-test statistics in analyzing the null hypotheses while the present study employed ANCOVA, t-test independent and Kruscal Wallis' test statistics at $P \leq 0.05$ level of significance to test the null hypotheses. The present study also focused on Organic Chemistry concepts, while the former focused on Geometry, Mathematics. However, the presence of perception and retention as dependent variable in the present study makes it unique from the above study.

Esin and Ali, (2016) determined the effect of self-regulated jigsaw IV upon university students learning a new grammar structure within EFL learning process and also their attitudes towards the English course. Non-equivalent control group pre-test and post-test design quasi-experimental design was employed in the study. The research was carried out with 40 students studying in two different prep classes at Bulent Ecevit University Foreign Languages College in the spring term of 2011-2012 academic years, Turkey. During the courses, while self-regulated jigsaw IV was carried out with the experimental group, a traditional method was performed in the control group. t-test a statistical tool at $P \leq 0.05$ level of significance was used to analyze the data collected. As quantitative data suggest; self-regulated jigsaw IV has significantly increased students' academic achievement compared to traditional method; however, it is slightly effective on their attitudes towards English. As qualitative data suggest; the students in the experimental group feel self-satisfied with their learning and they can use self-regulation skills in their

autonomous studies. The study is similar to the present one in terms of main research variable been Jigsaw IV Cooperative Learning Strategy, the research design being quasi-experimental design. However, the present study differs from the former in terms of location, sample size, statiscal tools used and the subject area. The study was conducted at Turkey University of Foreign Languages, while the present study was carried out in Zaria Education Zone, Kaduna, Nigeria. The study used t-test statistical tool in analyzing the null hypotheses while the present study employed ANCOVA, t-test independent and Kruscal Wallis' statistics at $P \leq 0.05$ level of significance to test the null hypotheses. The present study was focused on Organic Chemistry concepts, while the former study focused on English Language. However, the presence of perception and retention as dependent variables in the present study makes it unique.

2.11 Implications of Literature Reviewed for the Present Study

Science teachers have been relentlessly searching for the effective instructional strategy and fruitful curriculum materials that would collectively enhance the teaching and learning of sciences, Chemistry inclusive to the younger generation (Johnson &Johnson, 2009). Jigsaw IV cooperative learning strategy is one of such innovative teaching and learning strategy that provides an insight into relevance of students' perception to understanding and retention of science concepts.

Doymus, (2007); Jansoon, Samsook and Coll (2008); Egitim and Bilim (2013) and Mari and Gumel, (2015) stated that Jigsaw Cooperative Learning experiences promote academic performance, positive thinking and attitudes toward learning experiences than competitive or individual instructional strategy. Jansoon, *etal* (2008) for example

specifically revealed the relevance of students' perception towards understanding of science when Jigsaw IV Cooperative Learning Strategy is used in classroom setting. The students in Jigsaw IV Cooperative Learning settings are able to develop critical thinking process which involves: analysis, reflection, synthesis, and positive perceptions as they work together (Doymus, 2007).

From the reviewed literature, so far there is clear evidence that Jig-saw IV Cooperative Learning Strategy is superior to the Traditional Method of teaching, but majority of the studies reviewed in the literature were carried out at either primary schools or higher institutions and are mostly foreign studies. This study was conducted in Zaria, Kaduna state, Nigeria and at Senior Secondary School levels. A significance gender difference in the development of jigsaw cooperative learning strategy in favour of boys and some in favour of girls was reported in the studies cited in the literature. It is therefore hypothesized in the present study that this gender difference or disparity may be eliminated, or curtailed when Jigsaw IV Cooperative learning is used, this is simply because Jigsaw Cooperative Learning Strategy has unique characteristics of providing optimum opportunities for the students to independently study task given to individual member of the group, and explain the task to the other members of the home after discussion at the Jigsaw group or the expert group.

Most of the studies reviewed concentrated more on performance and attitudes. Little attempt was made to investigate the effectiveness of Jigsaw IV Cooperative Learning Strategy on students' perception and retention at Senior Secondary School Organic Chemistry concept. To fill in this gap this study investigated the effects of Jigsaw IV

Cooperative Learning Strategy on Secondary School students' Perception, Retention and Performance in Organic Chemistry in Zaria, Kaduna State, Nigeria.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This study investigates the "effects of JigsawIV Cooperative Learning Strategy on Secondary School Students' Perception, Retention and Academic Performance in Organic Chemistry concepts in Zaria Education zone, Kaduna State, Nigeria. This chapter describes the method and procedure for collecting data for this study. The methodology employed for the study is presented under the following sub-headings:

3.2 Research Design

3.3 Population of the Study

3.4 Sampling and Sampling Techniques

3.5 Instrumentation

3.5.1 Validity of the Instruments

3.5.2 Pilot Testing

3.5.3 Reliability of the Instruments

3.5.4 Item Analysis (Facility Index, FI & Discriminating Index, DI)

3.6 Administration of Treatment

3.7 Data Collection Procedure

3.8 Procedure for Data Analysis

3.2 Research Design

The design for this study is pretest, posttest, and post posttest quasi-experimental research design. This is according to Akuezuilo (1993) and Kerlinger and Leer (2005) that the design involves two groups, one group is assigned as experimental and the other group is the summed up advantages listed by (Lakpini, 2006) which is as follows;

i. The superiority of one instructional strategy over the other can easily be tested
ii. It gives indications of concept attainment ability of understanding gained by students after they have been exposed to a particular teaching treatment.
iii. The pretest scores gives indication as to whether the groups are equal in the concepts they hold before interaction was given.

The samples selected in this study were pre-tested to ensure that they are not significantly different. The experimental group (EG) was exposed to organic Chemistry concepts for six (6) weeks using Jigsaw IV Cooperative Learning Strategy while the control group (CG) was exposed to organic Chemistry concepts also for six weeks using lecture method. A post test was administered to observe if there was any significant difference in students' academic performance among the groups. The perception of the students in the experimental and control groups were also observed before and after the treatment. A post-post test was administered to both experimental and control group to observe if there was any significant difference in students' retention ability in organic concepts. The design is illustrated as follows in Figure 3.1

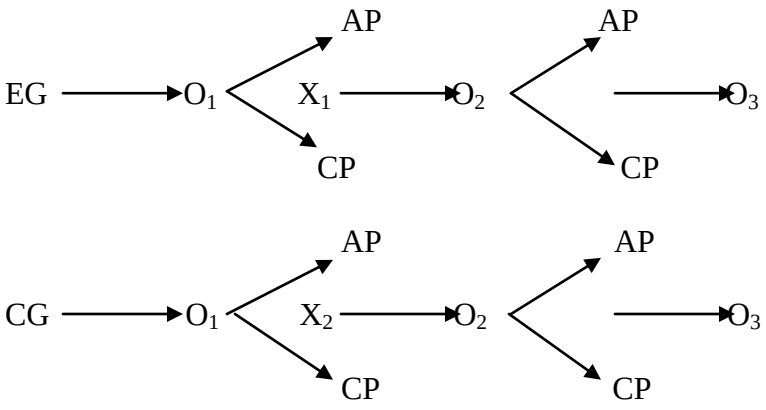


Figure 3.1 Research Design

Where:

EG = Experimental Group,

CG = Control Group,

O_1= Pretest,

O_2 = Posttest,

O_3 = Post posttest,

X_1 = (Treatment using Jig-saw (IV) Cooperative Strategy),

X_2 = Lecture Method,

AP= Academic Performance,

CP = Chemistry Perception.

3.3 Population of the Study

The population of this study comprised of all public co-educational senior secondary Schools (SS II) Students offering Chemistry as a subject in Zaria Education Zone. The public coeducational schools are selected for use in this study because of their convenience, population, readiness of school management to assist the researcher when conducting research and particularly gender issues among others. There are eleven senior

secondary schools with a total of 1,154 students. 711 students are males and 443 students are females. Detail of the population is shown in Table 3.1.

Table 3.1 Population of the Study

S/No.	Name of School	Location	SSII Enrolment No of Male	No of Female	Total
1	Govt. Senior Sec Sch Muchia	Sabon Gari	75	60	135
2	Govt. Sec. Sch. Aminu	Sabon Gari	70	43	113
3	GSS Magajia	Zaria	74	36	110
4	GSS Chindith Barraks	Sabon Gari	108	100	208
5	GSS T/ Jukun	Zaria	64	39	103
6	GSS Gyalesu	Zaria	48	29	77
7	GSS Kofar Kuyan Bana	Zaria	56	32	88
8	SIASSS Karau-Karau	Zaria	42	21	63
9	GSS Dakace	Sabon Gari	87	35	122
10	GSS Likoro	Sabon Gari	57	25	82
11	GSS Karau-karau B	Zaria	30	23	53
	Total		**711**	**443**	**1,154**

Source: Zonal inspectorate Division, Zaria (2017)

3.4 Sample and Sampling Techniques

The samples were selected using simple random sampling technique. To select the sample schools, the names of the eleven senior public co-educational schools were written on pieces of paper, squeezed and put in a container and one piece of paper was picked at a time. Each time, a piece was picked, the container was reshuffled before the

next was picked. Any school whose name appeared on the paper was taken as one of the six schools that served as sample. The process was repeated until all the six schools were selected. GSS Muchia, GSS Dakaci, GSS Aminu, GSS Magajiya, GSS Likoro and GSS T/ Jukun were randomly selected.

Furthermore, these schools were pretested to ascertain their academic equivalence or initial parity of the groups and reduce the internal validity threat which might have occured due to the non-random assignment of subjects using Organic Chemistry Performance Test (OCPT) and Organic Chemistry Perception Questionnaire (OCPQ). This was done to identify the two schools that were used as experimental and control groups. The mean scores of the six schools in the Organic Chemistry Performance Test (OCPT) were tested using Analysis of Variance (ANOVA) statistics and Scheffe's test of ANOVA result (see Appendix, F) to choose a pair of school that have no significant difference in their academic performance. In the pretest result the school A and B were found to have no significant difference and were therefore selected. School A was randomly assigned experimental while school B was tagged control group using tossing of coin. In each of these two schools, an intact class was used so that no student was left out.

Therefore this study consists of 234 students selected from the two schools, which is viable for the study and this is in line with the recommendation of Tuckman (1975); Frankel and Wallen (2000) and Sambo, (2008) that sample size of minimum of 30 students is viable for experimental study of this nature. Detail of the sampled schools is shown in the table 3.2 below.

Table 3.2 Sample of the Study

S/No.	Name of School	Male	Female	Total	Group
1	School A	73	37	110	Experimental
2	School B	72	52	124	Control
	Total	**145**	**89**	**234**	

3.5 Instrumentation

Two instruments were developed by the researcher for the purpose of generating data. These include;

1. Organic Chemistry Performance Test (OCPT) and
2. Organic Chemistry Perception Questionnaire (OCPQ).

1. Organic Chemistry Performance Test (OCPT)

The instrument has two sections (i.e A & B), section A is for demographic data and the section B is for the Performance Test. The OCPT is made up of 40 multiple choice test questions with four distracters or options (A, B, C & D) that were developed by the researcher from past WAEC questions papers to measure the students' performance in Organic Chemistry concepts taught. Each correct response attracts 1 mark. Thus the total mark awarded was (fourty) 40. The content taught includes;

a. Hydrocarbon,
b. Functional group/Homologous series,
c. Alkanes,
d. Alkenes and

e. Alkynes.

See appendix C (pg 143-150). The table of specification in Table 3.3 reflecting the six cognitive levels based on Blooms (1958) taxonomy for the cognitive domains, number of questions and numbers of questions based on Blooms taxonomy are shown below in Table 3.3 and 3.4 respectively.

Table 3.3: Table of Specification Based on Blooms' Taxonomy of Cognitive Domain

Content/ Objective	Weight	Know.	Comp	App	Ana	Syn.	Eva.	Total
	%	40%	28%	12	5%	10%	5%	100%
Hydrocarbon	20	4	3	-	-	1	-	8
		(1,2,3,5)	(6,7,8)			(4)		
Functional group/ Homologous Series	23	4	2	1	1	1	-	9
		(9,10,13,15)	(12, 14)	(11)	(16)	(17)		
Alkanes	17	2	2	2	-	-	1	7
		(21,23)	(18,22)	(19,20)			(24)	
Alkenes	20	3	1	2	1	1	-	8
		(25,26,31)	(27)	(28,29)	(32)	(30)		
Alkynes	20	3	3	-	-	1	1	8
		(37,39,40)	(33,34,38)			(36)	(35)	
Total	**100**	16	11	5	2	4	2	40

Source: Developed by the Researcher (2017)

Table 3.4: Specification of Items number

Content/Objective	Number of Questions
Hydrocarbon	1, 2, 3, 4, 5, 6, 7 & 8
Functional group/ Homologous series	9, 10, 11, 12, 13, 14, 15, 16 & 17
Alkanes	18, 19, 20, 21, 22, 23 & 24
Alkenes	25, 26, 27, 28, 29, 30, 31 & 32
Alkynes	33, 34, 35, 36, 37, 38, 39, 40

Developed by the Researcher (2017)

2. Organic Chemistry Perception Questionnaire (OCPQ)

The OCPQ was adapted from Basic Science Students Perception Questionnaire of Shafiu, (2014). The OCPQ consists of 24 items and was divided into two sections (i.e A and B). Section A consists of items on Bio Data, while section B is made up of questions on students' perception in organic concepts. The OCPQ was designed based on Likert 5-point scale of Strongly Agree (SA), Agree (A), Undecided (U), Disagree (D), and Strongly Disagree (SD) with their corresponding point of 5, 4, 3, 2 and 1 respectively. A detail of the OCPQ is shown in appendix D.

3.5.1 Validity of the Instruments

Content and face validity of OCPT and OCPQ were established by three Senior Lecturers with Ph.D qualification and above in the Department of Science Education, Ahmadu Bello University, Zaria and one senior lecturer with Ph.D qualification at the Department of Chemistry, Faculty of Physical Sciences, Ahmadu Bello University Zaria, to moderate the relevance, correctness, suitability, clarity, readability, unambiguity and

completeness and so on, of the items in consideration of the research objectives and null hypotheses as well as the respondents. However, Question 27 of OCPT was recast from;

"The addition of mineral acids to an alkene result in a product with the negative part of the acid bonded to 'the carbon atom that holds the lowest number of hydrogen atom". This statement is in accordance with:

The addition of mineral acids to an alkene result in a product with the nucleophile bonded to the carbon atom that holds the lowest number of hydrogen atom. This statement is in accordance with:

3.5.2 Pilot Testing

The essence of pilot testing is to find out how respondents would react to the instruments. The instruments OCAT and OCPQ were tried out in a pilot study in order to determine item difficulties, facility index, check the discriminating index, reliability coefficient and decide on the time limit for the test. For this study, the pilot testing was conducted at GSS Jama'a with a total number of 125 students made up of 75 males and 50 females using one short test. Period of 1hr was allocated for the students to answer the questions from OCPT and 30 minutes was given for OCPQ. This is in accordance with Shafiu, (2014).

3.5.3 Reliability of the Instruments

The purpose of reliability is to ascertain the feasibility and reliability co-efficient of the instruments used. In this study, the instrument was trial tested on fifty (50) students selected from GSS Jama'a Senior Secondary school of Giwa Local Government Area, Kaduna State Nigeria. The reliability coefficient of the instrument OCPT and OCPQ were computed by subjecting the scores collected to Cronbach Alpha coefficient, using

Statiscal Package for Social Sciences (SPSS) and the value were found to be r=0.88 and r= 0.76 respectively. This value suggests that the test questions were reliable and as such would test what it is designed to test.

3.5.4 Items Analysis

3.5.4.1 Facility Index (IF) for OCPT and OCPQ

Facility index of a test according to Sambo (2008) is the percentage of candidates that got an item right over the total number of respondents that attempted the item. It is determined by using the formula;

$$\text{FI} = \frac{R}{T} \times 100$$

Where FI = Facility Index,

R = Number of correct responses

T = Total number of students tested.

Sambo, (2008) opined that any item with FI between 40 – 60% is accepted. In this study, items with FI of 40 – 60% were accepted, while items with FI below or higher than 40 – 60% were changed or modified for been too simple or too difficult. Detail was shown in the Appendix G.

In Organic Chemistry Performance Test (OCPT) item 27 with difficulty index of 20% is dropped and replaced with more suitable items. However, all the items in the Organic Perception questionnaire (OCPQ) were found to have a difficulty index within the range of 40-60% were retained and used. This is in accordance with Sambo (2008).

3.5.4.2 Discriminating Index (DI) for OCPT and OCPQ

Discriminating index of a test is the capacity of a test item to distinguish between high and low achievers among sampled students. If the items show positive DI, it is an indication that there are large proportion of competent students that got the items right than those poor students that got the item right. But in a situation whereby the DI value is Zero, it implies that the item has zero Discriminating index as such the item does not distinguish between the low and high achievers among the sampled students. When the DI is negative, is an indication that there are more low achievers that got the answer right than those high achievers who got it right.

In this study, the DI was calculated using scores of the top twenty seven percent (27%) and the bottom twenty seven percent (27%) of the total respondents. This can be done using the formula given by Sambo (2008) as

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

Where DI = Discriminating Index

R_U = Number of students among the upper 27% who responded correctly

R_L = number of students among the lower 27% who responded to the item,

T = number of respondents

Tristan (1995) and Sambo (2008) recommended that items with DI which ranges from 0.40 – 0.60 is regarded as moderately positive and is accepted for this study. In Organic Chemistry Performance Test (OCPT) item 27 with difficulty index of 0.20 is dropped and replaced with more suitable items. However, all the items in the Organic Chemistry

Perception Questionnaire were found to have a discriminating index within the range of 0.4-0.7 were retained and used.

3.6 Administration of Treatment to Experimental Group

The following stages were followed for the purpose of administering the treatment:

Stage One: Introduction

The teacher introduces the lessons, principle and experiment to the students in a plenary session, and assigns students to a home group, containing six students. The members of each home group are divided into expert groups.

Stage two: Student Activity Using JigsawIV Cooperative Learning Strategy

The experimental group, was exposed to JigsawIV Cooperative Learning Strategy (treatment) by the researcher for six weeks of teaching via the following steps. Thus;

Step 1. Students were divided into 5 to 6-person jigsaw groups. Effort was made in making sure that the groups are diverse in terms of gender and varied ability.

Step 2. One student from each group was appointed as the group leader. His role was to coordinate the group discussion and maintain order. Other members of the group were assigned different roles. Example of such roles include time keeper who remains groups of the time left for group work.

Step 3. The days' lesson was also divided into 5-6 segments by the teacher corresponding to the member of the group.

Step 4. One segment of the lesson was assigned to each student in a group to learn making sure those students have direct access only to their own segment.

Step 5. Students were given time to read over their segment at least twice in order to

become familiar with it. The teacher encourages the students not to memorize the segment given to them.

Step 6. Temporary "expert groups" were formed. This was done by having one student from each JigsawIV group join other students assigned to the same segment. Students in these expert groups were given time to discuss the main points of their segment and to rehearse the presentations they made to their jigsaw group. The teacher went round to support the students.

Step 7. The students were asked questions based on their expert sheet to check their understanding prior to returning to their home group.

Stage Three: Discussion of their learning outcomes (Home Group Discussion)

Participants in the expert groups were asked to go back to their original home group to teach others the sections they have discussed. They were reminded to help each other to master the materials as much as possible. Each student who studied a particular segment was asked to present his or her segment to the rest of the group members. Other members of the group were encouraged to ask questions for clarification. The teacher then moved from group to group, observing the process.

Stage Four: Evaluation

The students were asked questions based on the stated specific objectives of the lessons. The whole classes were evaluated individually, and the scripts collected, were marked, recorded and returned during the next class.

Stage Five: Re-teaching

Re-teaching the main point and the missing parts at the end of each lesson after individual assessment was also conducted. The researcher emphasized to students the

need of J4CLS before the treatment. Students were also taught about the existence of group's goal, the need for sharing of opinions and materials, division of labour group reward. Students in J4CLS groups also learned skills which they need to facilitate their group interactions.

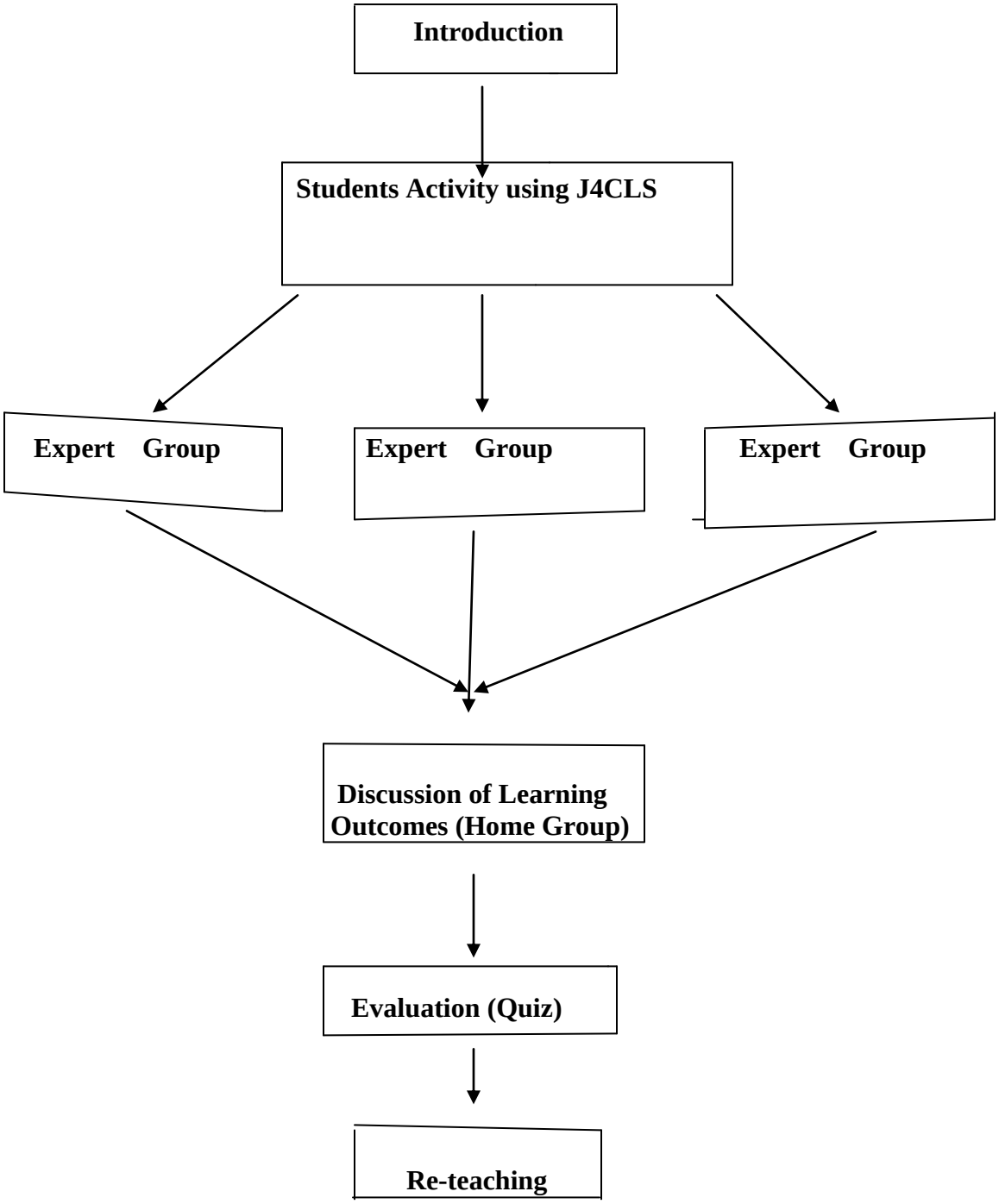


Fig 3.2. JigsawIV Cooperative Learning Flow Chart Adapted from (Ashiru, 2015)

Figure 3.2 shows the format of how jigsaw IV cooperative model is used in the experimental group. In this study, the students were first introduced to the lesson, after which they were given task to perform. The students were splitted into temporary expert group, where students assigned to same segment came together to discuss their task. After their elaboration and explanation in the expert group, they went back to their home group to explain to other members of the group. They now take individual assessment and the teacher reteaches the missing part of the lesson.

3.6.1 Treatment of the Experimental Group

Treatment in the experimental group was conducted by the researcher and two research assistant using the Jigsaw IV cooperative learning strategy (The Jigsaw model). This enabled the researcher to effectively handle the treatment group following all the necessary criteria for the adoption of the method. In this model, students were assigned into groups to work on academic materials that were broken down into sections. The teacher introduced the lesson to the students and explains to them what they are expected to do. For example, the concept of hydrocarbon was divided into meaning of hydrocarbon, types of hydrocarbon, source of hydrocarbon, characteristics of hydrocarbon, and uses of hydrocarbon. Each team member reads his or her section. Next, members of different teams who had studied the same sections, then meet in expert

groups and discussed their sections. Then the students returned to their teams and in turn teach their teammates about their sections.

This procedure was followed for all the remaining lessons. Treatment for the experimental group lasted for six weeks. After six weeks of treatment, a post-test was administered to determine the effect of treatment on the students' perception, and academic performance. Post post-test followed after two weeks interval for the determination of retention ability among the students.

3.6.2 Teaching of the Control Group

The control group was handled by the researcher and the teacher from the sampled school as control group. The same concepts were taught to the students using the traditional lecture method which last for the same period of weeks (six weeks) as the experimental group. The lesson note prepared by the researcher which was validated by panel of educationist was used to teach the control group. Test /assignment were given to the students at the end of each lesson. After six weeks of teaching, a post test using the Organic Chemistry Performance Test (OCAT) to determine the students' academic performance on Organic Chemistry in Zaria Education Zone. The details of lesson procedure for Jigsaw IV Cooperative Learning Strategy and lecture methods are presented in Appendix A & B respectively.

3.7 Procedure for Data Collection

The data collection for this study involves the following:

Organic Chemistry Performance Test (OCPT) which was given to both the experimental and control group as Pre-test and Post-test and Post-post test and marked over 40 as seen in Appendix C. The scores were computed into a computer based on the experimental and control group as well as gender.

Organic Chemistry Perception Questionnaire (OCPQ) was administered to both experimental and control group before and after the treatment in order to find out if the secondary school students had changed in their perception of Organic Chemistry concepts after exposure to Jigsaw IV Cooperative Learning Strategy. The scripts and questionnaire were marked and arranged based on Experimental and Control group and gender for analysis.

3.8 Procedure for Data Analysis

The data collected from the administration of the instruments was analyzed using appropriate statistical tool such as Analysis of Covariance (ANCOVA), Students t-test and Kruscal Walli's statistics at $P \leq 0.05$ level of significance in order to test for the stated null hypotheses. The hypotheses and the statistical tool used are restated as follows:

HO1: There is no significant difference between the mean performance scores of students taught Organic Chemistry using the Jigsaw IV Cooperative Learning Strategy and those taught using the Conventional Method of Teaching among SS II Students in Zaria Educational Zone.

An ANCOVA statistical tool was used in testing the null hypothesis.

HO2: There is no significant difference between students' perception of Organic Chemistry before and after exposure to Jigsaw IV Cooperative Learning Strategy

and those taught using Conventional Method of Teaching among SS II Students.

Kruscal Wallis' test statistical tool was used in testing the hypothesis.

HO3: There is no significance difference between the retention ability of Chemistry Students taught Organic Chemistry using Jigsaw IV Cooperative Learning Strategy and those taught using the Conventional Method of teaching among SS II Students.

An ANCOVA statistical tool was also used in testing the null hypothesis.

HO4: There is no significant difference between the mean performance scores of male and female Students taught Organic Chemistry using Jigsaw IV Cooperative Learning Strategy in Organic Chemistry.

t- test statistical tool was also used in testing this null hypothesis.

CHAPTER FOUR

DATA ANALYSIS, RESULTS PRESENTATION AND DISCUSSIONS

4.1 Introduction

In this chapter, the analysis of data and the results obtained from the study are presented. Statistical Package of Social Science (SPSS) was used to analyze the data at two different levels, VIZ: the research questions raised were answered using descriptive statistics such as mean standard deviation, variance and mean difference and the formulated hypotheses for the study were tested using ANCOVA, independent t- test and Kruscal-walli's test. The chapter also provided a brief summary of the findings. The hypotheses were retained or rejected at $P \leq 0.05$ level of significance. The chapter is presented in the following subheadings:

4.2 Analysis and Result presentation

4.3 Summary of findings

4.4 Discussion of the Results

4.2 Analysis and Results Presentation

The analysis and presentation of the results were conducted using descriptive statistics in responding to the research questions while inferential statistics was used to test the null hypothesis

4.2.1 Research Questions

Mean, standard deviation, variance and mean difference was used to answer the research questions. Thus;

Research Question One

Is there any difference between the mean academic performance scores of Senior Secondary School Students taught Organic Chemistry concepts using Jigsaw (IV) Cooperative Learning Strategy and those taught same concepts using Conventional Method?

To answer research question one, the mean score between the two groups was determined using descriptive statistics and the result is presented in Table 4.1.

Table 4.1.Mean and Standard deviation of students of experimental and control group

Group	N	Mean	Standard Deviation	Mean difference
Experimental	110	28.83	6.524	8.01
Control	124	20.82	3.727	

Table 4.1. Showed the computation of experimental and control group mean performance scores after exposure to Jigsaw IV Cooperative Learning Strategy and Conventional Lecture Method. The table shows that the experimental group had a mean performance score of 28.83, while the control group had a mean performance of 20.82. This shows that the students in the experimental group had some level of improvement as a result of exposure to Jigsaw IV Cooperative Learning Strategy compare to those in the control group. The standard deviation is an indicative value of wide variability between the scores of the group with a mean difference of about 8.01 mean differences.

Research Question Two

What is the students' Perception of Organic Chemistry concept before and after exposure to Jigsaw IV Cooperative Learning Strategy and Conventional Method of Teaching?

To answer this research question Mean Ranks and Standard Deviation was used as presented in Table 4.2.

Table 4.2: Mean Perception scores of experimental and control group before and after exposure to treatment.

Variable	Group	N	Mean Rank	Sum of Mean Rank	Mean Rank difference
Pretest	Experimental	110	119.88	235.27	4.49
	Control	124	115.39		
Posttest	Experimental	110	161.70	239.99	83
	Control	124	78.29		

From Table 4.2, there is a change between the perception scores of students in the experimental group exposed to Jigsaw IV Cooperative Learning Strategy and those exposed to Conventional Method Teaching. The mean rankings showed that in the pretest the perception score of experimental group was 119.27 while that of control group was 115.39. In their post- test scores the mean rankings showed that the perception score of experimental group was 161.70 while that of control group was to be 78.29. This shows that there is a significant positive change in the perception of students exposed to Jigsaw IV Cooperative Learning Strategy than their counterparts in the control group is observed.

Research Question Three

Is there any difference between retention ability of students taught Organic Chemistry concepts using Jigsaw IV Cooperative Learning Strategy and those taught same concepts using Conventional Method of Teaching?

To answer research question three, a descriptive statistics of mean and standard deviation was used. The detail of the result is presented in Table 4.3

Table 4.3: Mean score and Standard Deviation of Retention Ability of Students in the Experimental and Control Groups.

Group	N	Mean	Standard Deviation	Mean difference
Experimental	110	28.58	6.752	
				9.43
Control	124	19.15	3.940	

The results in Table 4.3 showed that the students in the experimental group with mean score of 28.53 retained higher than their counterparts in the control group with mean score of 19.15. This indicates that Jigsaw IV Cooperative Learning Strategy enhances students' retention.

Research Question Four

Is there any difference between the mean performance scores of male and female students taught Organic Chemistry using Jigsaw IV Cooperative Learning Strategy?

To answer question four, a descriptive statistics of mean scores and standard deviation was used. The detail of the result is presented in Table 4.4.

Table 4.4: Mean Performance of Male and Female Students in the Experimental Group

Sex	N	Mean	Standard Deviation	Mean difference
Male	73	30.47	5.677	
				1.61
Female	37	28.86	4.979	
Total	110			

There is no difference in the retention of male and female senior secondary Chemistry students of varied abilities in the experimental group. From Table 4.4, the performance of male and female in the experimental group was 30.47 and 28.86 respectively.

4.2.2 Hypotheses Testing

For the inferential analysis, ANCOVA, Kruscal Wallis' and t-test statistics were used to test the null hypothesis at $P \leq 0.05$.

HO_1: There is no significant difference between the mean performance scores of students taught Organic Chemistry using the J Jigsaw IV Cooperative Learning Strategy and those taught using the Conventional Method of Teaching.

To determine whether there was significant difference in the post-test mean scores of the Jigsaw IV Cooperative Learning Strategy and the control group (Conventional Method of Teaching, CMT), data were analyzed using the analysis of covariance (ANCOVA). Table 4.5 contains the result of the analysis.

Table 4.5: ANCOVA Post-test Comparison of Mean Performance Scores of Experimental (Jigsaw IV) and Control (CMT) Croups

Source of Variation	Type III Sum of Squares	Df	Mean Square	F	P-value	Remark
Covariate (pretest)	4.957	1	4.957	0.179	0.673	*NS
Intercept	58651.720	1	58651.720	2114.750	0.001	*S
Group (Treatment)	3648.616	1	3648.616	131.555	0.001	*S
Corrected Model	3649.088	2	1824.544	65.786	0.001	*S
Residual (Error)	6406.690	231	27.735			
Total	151152.000	234				

Where *S = Significant at P≤0.05, *NS= Not significant

Table 4.5 shows the main effect of experimental group (Jigsaw IV Cooperative Learning Strategy) on students performance produced an F=131.555, P value of 0.001) for the main effect (treatment) was significant. This is because the intercept P value of 0.001 is less than the alpha value of 0.05 level of significance. Therefore, the result indicated that the treatment, using Jigsaw IV Cooperative Learning Strategy accounted for the difference in the post-test performance scores of the students. Hence, the null hypothesis one which states that 'there is no significant difference in the mean performance scores of students taught Organic Chemistry concepts using the Jigsaw IV Cooperative Learning Strategy and those taught using the Conventional Method of Teaching' is hereby rejected. This therefore means that there is a significant difference in the mean performance scores of students taught Organic Chemistry using the Jigsaw IV Cooperative Learning Strategy and those taught using the CMT.

$H0_2$: There is no significant difference between the perception of students taught Organic Chemistry concepts before and after exposure to Jigsaw IV Cooperative Learning Strategy and Conventional Method of Teaching.

To determine whether there was significant difference in the pre-test (Perception before the treatment) and post-test (Perception after the treatment) perception mean values of students exposed to Jigsaw IV Cooperative Learning Strategy and CMT, data was analyzed using the Kruscal Walli's statistics. The results of this hypothesis is as shown in Table 4.6

Table 4.6: Comparison of Mean Rank Perception Scores of students in Experimental and Control Groups Using Kruscal Walli's Statistics

Variable	Group	N	Mean Rank	Sum of Mean Rank	*df*	P value	Remark
Pretest	Experimental	110	119.88	235.27	1	0.611	*NS
	Control	124	115.39				
Posttest	Experimental	110	161.70	239.99	1	0.001	*S
	Control	124	78.29				
	Total	234					

Where *S = Significant at $P \leq 0.05$, *NS= Not significant

From Table 4.6, shows that there is no significant difference in the perception scores student in both experimental and control group before the treatment. This is because the pretest had a p-value of 0.611 which is greater than alpha value of 0.05. However, after administering the treatment to the treatment group, significant difference exist in the perception of SSII chemistry students taught Organic Chemistry with Jigsaw IV Cooperative Learning Strategy than those exposed to Conventional Teaching Method. This is because the P-value of 0.001 is less than the alpha value of 0.05 level of significance. This significant difference in the perception of students taught Organic

Chemistry concepts using Jigsaw IV Cooperative Learning Strategy and CMT in favour of the experimental group. The hypothesis two which states that "there is no significant difference in students' perception of Organic Chemistry before and after exposure to Jigsaw IV Cooperative Learning Strategy and those taught using Conventional Method of Teaching" is therefore rejected. This indicates that students' perception towards Organic Chemistry concepts before the treatment (pretest) differ significantly from perception after the treatment (posttest) when exposed to Jigsaw IV Cooperative Learning Strategy. This means that when students are exposed to Jigsaw IV Cooperative Learning Strategy, they developed positive perception which in turn enhances their performance.

HO3: There is no significance difference between the retention ability of Chemistry students taught Organic Chemistry using Jigsaw IV Cooperative Learning Strategy and those taught using the Conventional Method of teaching.

Analysis of Covariance (ANCOVA) was used in testing this null hypothesis as presented in Table 4.7

Table 4.7 Analysis of Covariance (ANCOVA) of difference in the mean retention ability of Experimental and Control Groups.

Source of Variation	Type III Sum of Squares	*df*	Mean Square	F	P-value	Remark
Covariate (pretest)	126.413	1	126.413	4.325	0.673	*NS
Intercept	51143.860	1	51143.860	1749.806	0.001	*S
Group (Treatment)	5228.790	1	5228.790	178.895	0.001	*S
Corrected Model	5317.219	2	2658.610	90.960	0.001	*S
Residual (Error)	6751.738	231	29.228			
Total	151152.000	234				

Where *S = Significant at P≤0.05, *NS= Not significant

From Table 4.7, Analysis of Covariance (ANCOVA) statistics showed that significant difference exists in the mean retention ability of SS II Chemistry students taught Organic Chemistry concepts with Jigsaw IV Cooperative Learning Strategy and those taught with lecture method. Reasons being that the intercept P-value is 0.001 which is less than the alpha value of P≤ 0.05 level of significant. This therefore means students exposed to J4CLS retained Organic Chemistry concept better than those exposed to CMT. The null hypothesis three which states that 'there is no significance difference in the retention ability of Chemistry students taught Organic Chemistry using Jigsaw IV Cooperative Learning Strategy and those taught using the Conventional Method of teaching' is hereby rejected.

HO4: There is no significant difference between the mean performance scores of male and female Students taught Organic Chemistry using J Jigsaw IV Cooperative Learning Strategy.

To test the hypothesis, the mean gain obtained by male and female subjects exposed to Jigsaw IV Cooperative Learning Strategy were compared by the use of t-value at alpha (ά) level of 0.05 as shown in Table 4.8

Table 4.8: t-test Analysis of Mean Performance Scores of Male and Female Students in the Experimental Group

Sex	N	Mean	Std. Deviation	*t-cal.*	*df*	*P value*	Remark
Male	73	30.47	5.677	1.46	108	0.857	*NS
Female	37	28.86	4.979				
Total	110						

Significant at P≤0.05, *NS= Not significant

Table 4.8 shows that there is no significant difference in the posttest scores of male and female Chemistry students taught Organic Chemistry concepts using Jigsaw IV Cooperative Learning Strategy. This is simply because the *t-cal.* which is 1.46 and *p*-Value of 0.857 which is greater alpha value of 0.05 level of significance. Therefore, the null hypothesis which states that there is no significant difference in the mean achievement scores of male and female students taught Organic Chemistry concepts using Jigsaw IV Cooperative Learning Strategy is hereby retained.

4.4 Summary of Findings

Based on the data analysis the following findings were made:

i. Significant difference exists in the mean scores of science students taught organic Chemistry concepts with Jigsaw IV Cooperative Learning Strategy and their counterparts taught with CMT in Zaria Educational Zone, Kaduna, Nigeria.

ii. There is a significant difference in the perception scores of students taught Organic Chemistry concepts using the Jigsaw IV Cooperative Learning Strategy and their counterparts taught same concepts using CMT.

iii. Significant difference exists in the retention ability between Senior Secondary School Student taught Organic Chemistry concepts using Jigsaw IV Cooperative Learning Strategy and those taught using CMT. This testified that Jigsaw IV Cooperative Learning Strategy enhances more retention among chemistry students than CMT in senior secondary schools of Zaria Educational Zone, Kaduna, Nigeria.

iv. There is no significant difference between academic performance scores of male and female secondary school students taught Organic Chemistry concepts using Jigsaw IV Cooperative Learning Strategy. This indicates that Jigsaw IV Cooperative Learning Strategy is gender friendly.

4.4 Discussion of Findings

Hypothesis one indicates that, a significant difference exists in the mean performance scores of SS II students taught Organic Chemistry concepts with Jigsaw IV Cooperative Learning Strategy and their counterparts taught with CMT (see table 4.5). This significant difference found in the performance of students taught Organic Chemistry was in favour of the experimental group. The superiority of Jigsaw IV Cooperative Learning Strategy stems from the fact that it was a task structured, that is the students were divided into small groups of 5-6 known as the Jigsaw groups, and the concept to learn was broken into segments. Each student in the Jigsaw group was assigned a segment to specialize on as all students with same topic or segment to form the expert groups. After the discussion and elaboration at

the expert group, the students reconvened at their Jig-saw groups where each expert explained his/her topic to other member of the Jig-saw group after which they took up quiz individually without help or assistance from the other group members. This discussion and elaboration at both expert and jigsaw groups enhanced meaningful learning of the whole lesson as such produced a positive learning outcome. This was why significant difference exists and a better performance was observed on students taught using Jigsaw IV Cooperative Learning Strategy than those taught using chalk and talk method.

This finding which indicates better performance of students exposed to Jigsaw IV Cooperative Learning Strategy group as compared to those exposed to CMT group agree with earlier findings of Yusuf, Gambari and Olumorin (2015) in physics; Timaye *etal* (2015) in mathematics and Mari and Gumel (2015) in Chemistry. Specifically, the finding of Yusuf, Gambari and Olumorin (2015) indicated that students taught physics using computer-supported Jigsaw II performed better than those taught using individualized computer instruction. The finding was so because, their study employed quasi-experimental design where intact class was used. The students in the experimental group were taught Physics concepts using Jigsaw model and the students in the control group were taught Individualized Computer Instruction (ICI) for the period of six weeks like the present study. The study selected two senior secondary school (SS II) physics students in Minna, Niger State, Nigeria which comprised of 80 students using simple random technique like the present study. Moreso, the sample size was in line with the recommendation given by Tuckman (1975); Frankel & Wallen (2000) and Sambo, (2008) that sample size of minimum of 30 students is viable for experimental study of this

nature. Also, both studies were carried out in the northern part of the country as such, the students felt motivated when they work in a jigsaw cooperative learning groups. Hence, improve their performance in science subjects.

The finding of Timayi *et al* (2015) revealed that a significant difference in performance of students exposed to the Jigsaw IV Cooperative Learning Strategy when taught Geometry than those taught same concept using traditional method. The study used quasi experimental research design involving a pretest and posttest like the present study. Two coeducation schools were also selected using simple random sampling as the sampled schools with a sample size of 144 (n=72 for experimental group and n=72 for the control group). Students in the experimental group was taught Geometry using Jigsaw IV Cooperative Learning Strategy and those in the control group was exposed to lecture method for a period of six weeks also, which gave the students ample opportunity to interact with themselves within the jigsaw group as such explained and elaborated the idea of Geometry concepts to themselves. This therefore enables them to learn meaningfully, which in turn enhances their academic performance. It was also observed that the study was carried out in Zaria Education Zone that means the students have same Educational background, Educational facilities and are always motivated when taught sciences using jigsaw iv cooperative learning, which is why the finding is similar to the present study.

Gumel (2015) in their study found that the use of cooperative (Jigsaw model) learning strategy has significant effects on the academic performance of formal reasoners more than that of the concrete reasoners. This finding emanated after exposing the experimental group to the jigsaw model of cooperative learning and the control group to

the traditional method. Though the study was carried out at NCE level, yet the performance of students in Jigsaw IV Cooperative Learning Strategy improved over those of their counterparts in the control group that were taught organic chemistry concepts using traditional method of teaching. This was because the students worked together in groups, where each student became an 'expert' on a specific topic, and subsequently, taught this to his or her home group. This enhanced their academic performance and which is why the finding is similar with the present study.

However, the finding disagree with the findings of Ross, Seaborn and Wilson (2002) and Thompson and Pledger (1998) who found no significant difference in the performance of students taught using Jigsaw and those taught using conventional classroom and discussion methods respectively. Ross, Seaborn and Wilson (2002) examined the impact of cooperative learning (Jigsaw model) as a valuable instructional method for teaching social studies to Urban African American students. The study was carried out on African American Students in Social Studies at United State of America, perhaps the use of cooperative learning strategy (Jigsaw model) in American system of Education is no longer a new innovative strategy. The students are used to it and they don't get any much motivation from it talk more of improving their academic performance. Besides that, the study was carried out in Social Studies which is mostly taught in Nigeria system of education as such they lack the enthusiasm to learn the subject. This therefore, leads to no significant difference in the performance of students exposed cooperative learning strategy when taught Social Studies concepts than those taught using individualized method.

Hypothesis two indicated that a significant difference exists in the perception of students taught Organic Chemistry concepts using Jigsaw IV Cooperative Learning Strategy and their counterparts exposed to CMT. The significance difference in perception scores of students was in favour of the experimental group (see table 4.6). This was due to the fact that students in Jigsaw IV group are allowed to discuss their specific topic within their expert group; reconvened to their home group and explained to the other members of the group. The consistency of students in the home groups to explain their task increased their conceptual understanding, developed self- confidence, and enhanced communication skills and positive perception regarding the topic and the subject at large.

The finding of hypothesis two agrees with the earlier findings of Doymus, (2007) and Jansoon, *et al* (2008) which reveals that innovative teaching strategy particularly Jigsaw cooperative learning setting increases students' positive perception towards learning. Jansoon, *et al* (2008) specifically, examined Student perceptions of their learning of dilution Chemistry via the Jigsaw IV approach in practical class at Thai University, Thailand. In the Jigsaw IV approach as they applied during practical classes, the students worked together in groups, and employed more interactive learning strategies. In particular, each student became an 'expert' for a specific topic, and subsequently taught this to his or her home group. As such they gained positive perception/self-confidence after completing the experiments. Despite that the study was carried out at university level, the students developed positive perception as a result of interactive discussion in the jigsaw groups as such the result was similar to the present one.

Hypothesis three shows that significant difference exists in the mean retention abilities of SS II Chemistry students taught organic concepts with Jigsaw IV Cooperative Learning Strategy and those taught with CMT. The analysis of the hypothesis three showed that the

use of Jigsaw IV Cooperative Learning Strategy led to higher retention than the traditional method of teaching. The result of the mean scores of the students in the experimental group maintained a higher retention rates than their counterparts in the control group (see table 4.7).

The nature of Jigsaw IV Cooperative Learning Strategy is learning by doing and elaborating. In Jigsaw IV Cooperative Learning Strategy, the students worked together in groups, where each student became an 'expert' for a specific topic, and subsequently taught this to his or her home group. The consistent elaboration of organic concepts at Jigsaw groups provides students who either received the explanation or those who gave the explanation with a deep understanding and a more complete retention of the concepts being learnt for a longer period of time. The postpost test was administered after two weeks and the result is showed in table 4.7. This finding agrees with the findings of Sousa, (2006) Tanel and Erol (2008), who found that students in the experimental group taught science concepts with Jigsaw cooperative learning settings had higher retention than those in control group, taught science concepts using traditional method.

Specifically, the finding of Sousa (2006) reports the average percentage of learning material retention after 24 hours when students were taught by different teaching methods. He indicates that there was retention of 50% of material learned in the discussion group, 75% as a result of requests for students to study through practice, and 90% when students teach others in a jigsaw cooperative learning strategy.

An impressive study which lasted for 4 weeks was conducted by Tanel and Erol (2008) in which the effectiveness of the jigsaw learning method and conventional teaching method were compared on achievement and retention in a Physics course in a University in

Turkey. An experimental group received the jigsaw technique and a control group received traditional teaching. Results from the t-tests indicated that there were significant differences ($p < .001$) on the Postpost test scores after two weeks of the treatment as the present study.

Hypothesis four indicated that there is no significant difference in the performance of male and female students taught Organic Chemistry concepts using Jigsaw IV Cooperative Learning Strategy. Results of hypothesis two shows that Jigsaw IV Cooperative Learning Strategy does not differentiate the academic performance of both male and female students taught Organic Chemistry concepts. The gender equality among students in Organic Chemistry concepts in Zaria Education Zone was due to the fact that Jigsaw IV Cooperative Learning Strategy allows both male and female students within the home group to actually discuss their task to other members and take on individual quiz at the end of the task. Therefore, promotes their understanding of the concept, enhances their performance and bridged the gap between performance male and female students.

This finding is in line with that of Yusuf, *etal* (2015) and Timayi *et al* (2015) who individually found out that there is no gender difference in the academic performance of male and secondary school students exposed to Jigsaw IV Cooperative Learning Strategy as explained in hypothesis one. The finding is however in disagreement with that of Olson (2002) which reported that females performed better than males students when taught mathematics using Jigsaw II cooperative learning. This perhaps was due to the fact that the study was carried out at Western Australia University, perhaps students were not grouped into heterogenous groups of male female so as to enhance interactive effect of

male and female students in the jigsaw groups. That might be the reason why the female students performed significantly better than their counterpart. Furthermore, the finding agree with that of Adeyemi (2008) and Ajaja & Eravwoke (2010) which reported that gender had no influence on academic performance of students in cooperative learning strategy. This is because both studies adopted Jigsaw model and all students were divided into jigsaw groups of different gender and were assigned a specific task to perform. Both male and female students discussed and elaborated their portion of the lesson at the jigsaw groups (home groups). This group's interaction enables all students irrespective of their sex to improve in their performance. This therefore shows that Jigsaw IV Cooperative Learning Strategy is gender friendly.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This study investigates the effects of Jigsaw IV Cooperative Learning Strategy on students' Perception Retention and Academic Performance in Zaria, Kaduna State, Nigeria. This chapter summarizes the entire study and is presented under the following sub-headings:

5.2 Summary

5.3 Conclusion

5.4 Contribution to Knowledge

5.5 Recommendations

5.6 Limitations of the Study

5.7 Suggestions for Further Studies

5.2 Summary of the Study

The study was prompted by the prevalence of poor academic performance of senior secondary school students in Senior Secondary Certificate Examination (SSCE) due to poor quality of teaching and learning of Chemistry at senior secondary schools levels. Four research objectives, research questions and null hypotheses were formulated. Available literatures relevant to the study were reviewed. Most of these literatures concluded that academic performance can be enhanced using effective instructional strategies which recognized active participation of students such as Jigsaw IV cooperative learning strategy.

The design of the study was quasi-experimental and control group design employing Pretest and Posttest and Post-posttests (Akuezuilo, 1993 and Kerlinger & Leer, 2005). The population of the study consists of all the 1,154 SS II senior secondary science students (711 males and 433 females) in all the coeducational Senior Secondary Schools in Zaria Educational Zone. Two schools were sampled out from the population of the study using simple random sampling technique by balloting method and were assigned to experimental and control group. Two hundred and thirty four (234) SS II students (146 males and 88 females) were used based on the recommendation of Tuckman (1975); Frankel & Wallen (2000) and Sambo, (2008) that sample size of minimum of 30 students is viable for experimental study of this nature.

Two instruments, Organic Chemistry Performance Test (OCPT) and Organic Chemistry Perception Questionnaire (OCPQ) were used for data collection. The Organic Chemistry Performance Test (OCPT) consists of 40 multiple choice items on Organic Chemistry concepts with reliability coefficient of 0.88. While the Organic Chemistry Perception Questionnaire (OCPQ) was used on SS II students to test for change in perception scores after being taught with Jigsaw IV Cooperative Learning Strategy and CMT. The questionnaire consists of 24 statements constructed based on Likert five- point Scale of Strongly Agree (SA), Agree (A), Undecided (UD), Strongly Disagree (SD) and Disagree (D) for 5,4,3,2 and 1 respectively. The reliability coefficient of OCPQ was found 0.76 using alpha cronbach statistics. The treatment lasted for six weeks comprising of six periods of 80 minutes each. The data collected through the use of OCPT and OCPQ were subjected to Analysis of Covariance (ANCOVA), t-test statistics and Kruscal Wallis test statistics at $P \leq 0.05$ was used to determine the significant difference in the academic

performance, retention and perception of students in both experimental and control groups. The results indicated that the academic performance of SS II students taught Organic Chemistry concepts using Jigsaw IV Cooperative Learning Strategy was significantly better and retained higher than those taught with CMT. Positive perception was observed on students exposed to Jigsaw IV Cooperative Learning Strategy than those exposed to CMT. Gender had no significant effect on students' academic performance in Organic Chemistry concepts when Jigsaw IV Cooperative Learning Strategy is used. From the results obtained, hypotheses one, two and three of the study were rejected, while hypothesis four was retained. Finally, summary, conclusion, contributions to knowledge, recommendations, limitations of the study as well as suggestion for further studies were fully described at the last chapter of the study.

5.3 Conclusion

As a result of the findings in this study, it could be concluded that J4CLS enhances the understanding and retention of Organic Chemistry concepts of secondary school students. This is because all SS II students exposed to Jigsaw IV Cooperative Learning Strategy, performed and retained Organic Chemistry concepts better than those exposed to lecture method. Jigsaw IV Cooperative Learning Strategy was found to equally enhanced the performance of both male and female students. This shows that it is gender-friendly and could be a good instructional in coeducational study. Perception of SS II students exposed to Jigsaw IV Cooperative Learning Strategy was drastically increased compared to those taught with lecture method. This is because when students become active creator of their knowledge, analyzed such knowledge and apply it to a real life situation as in Jigsaw IV Cooperative Learning Strategy, it enhances positive perception with regards to

such concepts. Therefore, Jigsaw IV Cooperative Learning Strategy was established to improve students' perception of Organic Chemistry concepts than the CMT used in the control group.

5.4 Contributions to Knowledge

i. The Jigsaw IV Cooperative Learning Strategy improves academic performance of senior secondary school students in Organic Chemistry.
ii. Jigsaw IV Cooperative Learning Strategy enhanced the retention ability of senior secondary school students in Organic Chemistry.
iii. Jigsaw IV Cooperative Learning Strategy enhanced the acquisition of positive perception of Organic Chemistry concepts.
iv. Both gender benefitted equally well when taught Organic Chemistry concepts using Jigsaw IV Cooperative Learning Strategy.
v. The instruments developed can be used in science education to evaluate students understanding of Organic Chemistry concepts.

5.5 Recommendations

On the basis of the findings and conclusion emanating from this study, the following recommendations are made:

i. The use of Jigsaw IV Cooperative Learning Strategy seems to be appropriate in improving the performance and retention ability of students in senior secondary schools Organic Chemistry. It should therefore, be incorporated into the main stream of pedagogy in the teaching of Chemistry and other science subjects at senior secondary schools in Zaria Educational Zone, Kaduna, Nigeria.

ii. The use of Conventional Method of Teaching has been found in this study, to be relatively ineffective, with respect to perception, retention and academic performance in the learning of Organic Chemistry concepts. Chemistry teachers should therefore, exercise caution and expertise in enriching the CMT with innovative strategy such as Jigsaw IV Cooperative Learning Strategy so as to avoid situation where under achievement is unwittingly promoted in the course of teaching.

iii. In-service training programmes for science teachers in form of seminars, workshops and conferences should focus more on how to use Jigsaw IV Cooperative Learning Strategy in teaching of Chemistry concepts (Organic Chemistry) than is presently done.

iv. It was found in this study that, gender does not play a significant role in the learning of Organic Chemistry concept using Jigsaw IV Cooperative Learning Strategy. A common curriculum for male and female students and a common instructional strategy may be found adequate for secondary school Chemistry students, at least at secondary school level on which this study focuses.

v. Jigsaw IV Cooperative Learning Strategy encourages verbalization and reorganization of science in the learners' cognitive structure. It should therefore be encouraged for teaching in science classroom.

vi. It is also recommended that those teachers' training institutions such as colleges of education and universities should incorporate Jigsaw IV Cooperative Learning Strategy, into their methodology curriculum at all levels. This will ensure the development of its knowledge in the teachers on training.

5.6 Limitations of the Study

This study has the following limitations:

i. The study is restricted to only two Co-education senior secondary schools in the Zaria Educational Zone, Kaduna, Nigeria as such generalization of the study is narrow.

ii. Over population in the schools selected for the study caused the researcher to seek for the help of four (4) research assistants in the treatment school, the treatment was almost difficult to implement without trained research assistants.

iii. The training sessions organized for research assistants in this study may not have been sufficient enough for the expected level of mastery of Jigsaw IV Cooperative Learning Strategy.

iv. Re-teaching of the missing concept and difficult tasks always takes place during the next lesson because of time constrain.

5.7 Suggestions for Further Studies

From the available literature, it is obvious that not much work had been carried out in the area of Jigsaw IV Cooperative Learning Strategy, most especially in organic chemistry. The researcher is of the opinion that further studies be carried out to cover other abstract concepts of Chemistry and other science subjects. The following suggestions are therefore made to further expand the scope:

1. A similar study on senior secondary school students should be carried out focusing on the teaching of other science subjects using Jigsaw IV Cooperative Learning Strategy with a view to finding out if similar or different results as in this study may be obtained.

2. This study can be extended to students of tertiary institutions such as, Colleges of Education, Polytechnic and University to investigate if these levels of education will have similar effect on the variables that this study dealt with.
3. In order to increase the scope of generalization, this study should be replicated in other geopolitical zones of Nigeria and many other countries of the world.
4. There is need to further investigate the role if any, that gender difference play in the interaction between teaching strategy and the kind of curriculum as different studies seem to be showing different result.

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APPENDIX A

LESSON PLANS FOR EXPERIMENTAL GROUP

LESSON PLAN ONE:

Subject: **Chemistry**

Topic: **Hydrocarbon**

Group: **Experimental**

Class: **SSII**

Age: **16-17 years**

Sex: **Mixed (boys and girls)**

Main activity: **Studying the meaning, classes, sources and uses of hydrocarbons**

Teaching Model: **Jigsaw IV Cooperative Learning Strategy (Jigsaw model)**

Materials:

- Worksheets for all student: Hydrocarbons
- Copies of study notes to all expert students on :
- Meaning of hydrocarbon
- Classification of hydrocarbons
- Properties of hydrocarbons
- Sources of hydrocarbons
- Uses of hydrocarbons

Objectives:

Cognitive: at the end of the lesson the students should be able to:

(a. Define hydrocarbon

(b. Enumerate and briefly explain the two classes of hydrocarbon

(c. Mention four sources of hydrocarbon

(d. State any four uses of hydrocarbon

Affective: the students should be able to work cooperatively in a jigsaw group

Entry Behaviour: Students were taught periodic table and they know the position of Carbon and Hydrogen

Roles Assign to group members

Organizer: Collect group files containing materials; Distribute material to group members; Return materials to the files then to the teacher (researcher)

Reader: Reads the group task to the members

Timer: Keeps track of time; makes sure everyone contributes to answer the question

Encourager: Encourages group members; Decides on the order for the members to read the Task.

Introduction

The teacher introduces the lesson by explaining to the student that they are going to learn hydrocarbon using Jigsaw IV Cooperative learning strategy where all of them will work cooperatively together, and that the success of the group depend on the success of the individual member of the group.

Presentation:

The teacher presents the lesson through the following steps

Step 1. Assigning students into Groups

The teacher then groups the students into a Jigsaw cooperative learning groups comprising of five students per group. Making sure the groups are heterogeneous. Each student in a group is to be assigned a different task to perform. To begin the lesson, the teacher gives each group name written on a card. Each individual member of the group will then be given specific task to work/study. His/her expert name attached to the study note that is given to him/her. Each expert is asked to study his/her task for some time. No student in the same group was allowed to see the task given to his fellow group member. Students studying the same task from each group will then be asked to form expert

groups where they study collectively the task and record useful information or the worksheet earlier provided for the purpose of the feedback to his/her jigsaw group.

Step 2. Activity: the activity outlines for expert groups (EPG) are as follows;

EPG A. Members of this group discussed the meaning of hydrocarbon

EPG B. Members of this group discussed the classes of hydrocarbon

EPG C. Members of this group discussed the properties of hydrocarbon

EPG D. Members of this group discussed the sources of hydrocarbon

EPG E. Members of this group discussed the uses of hydrocarbon

Step 3 Expert Group Discussions

Expert groups are formed by having one student from each JigsawIV group to join other students assigned to the same segment. Students in these expert groups are given time to discuss the main points of their segment and to rehearse the presentations they make in their jigsaw group. The teacher goes round supporting the students.

Step 4. Discussion of their learning outcomes (Home Group Discussion)

Members of the expert groups are after sometime be asked to break and go back to their main group known as jigsaw groups where each expert explains his/her task to the remaining member of his/her group. Other members of the group were encouraged to ask questions and clarification from the expert group where necessary. As the group discussion is on, members of the groups assigned to perform certain role like the time keeper, questioner, reader, reminder and so on does the job.

Activity 1: work sheet for EPG A

Define Hydrocarbon

_____

_____

_____

_____

Activity 2: work sheet for EPG B

What are the classes of Hydrocarbon?

_____
_____
_____
_____
_____
_____
_____

Activity 3: work sheet for EPG C

Mention the four properties of Hydrocarbons

1._____
_____
2._____
_____
3._____
4._____
_____

Activity 4: work sheet for EPG D

State any four sources of Hydrocarbons

1._____
2._____
3._____
4._____

Activity 5: work sheet for EPG E

Highlight any four uses of Hydrocarbons

1._____
2._____
3._____
4._____

Evaluation: The researcher evaluates the lesson by giving the students the following quiz to answer individually:

1. What is hydrocarbon?
2. Briefly explain the two classes of hydrocarbon

3. Mention any four properties of Hydrocarbons
4. State any four sources of Hydrocarbons
5. Highlight any four uses of Hydrocarbons

The teacher will collect the answers to the question, mark and score it for each student and return them during the next lesson.

Conclusion: The teacher concludes the lesson by re-teaching the main idea or missing part of the lesson.

LESSON PLAN TWO:

Subject: **Chemistry**

Topic: **Functional Group/Homologous series**

Group: **Experimental**

Class: **SSII**

Age: **16-17 years**

Sex: **Mixed (boys and girls)**

Main activity: **Studying the meaning of functional group, Homologous series, their characteristics, identification of functional group in a given compound**

Teaching Model: **Jigsaw IV Cooperative Learning Strategy (Jigsaw model)**

Materials:

- Worksheets for all student: Functional group/ Homologous series
- Copies of study notes to all expert students on :
- Meaning of Functional
- Identification of functional group in a given compounds
- Meaning of homologous series
- Characteristics of homologous series
- General molecular formula of the following homologous series (a) alkanes (b) alkenes (c) alkynes (d) alcohol.

Objectives:

Cognitive: at the end of the lesson the students should be able to:

a. Define Functional group
b. Identify the functional group in a given compounds
c. Mention four sources of hydrocarbon
d. State any four uses of hydrocarbon

Affective: the students should be able to work cooperatively in a jigsaw groups

Entry Behaviour: The students were taught hydrocarbons

Roles Assign to group members

Organizer: Collect group files containing materials; Distribute material to group members; Return materials to the files then to the teacher (researcher)

Reader: Reads the group task to the members

Timer: Keeps track of time; makes sure everyone contributes to answer the question

Encourager: Encourages group members; Decides on the order for the members to read the Task.

Introduction

The teacher introduces the lesson by explaining to the student that they are going to learn hydrocarbon using Jigsaw IV Cooperative learning strategy where all of them will work cooperatively together, and that the success of the group depend on the success of the individual member of the group.

Presentation:

The teacher presents the lesson through the following steps

Step 1. Assigning students into Groups

The teacher then groups the students into a Jigsaw cooperative learning groups comprising of five students per group. Making sure the groups are heterogeneous. Each student in a group is to be assigned a different task to perform. To begin the lesson, the teacher gives each group name written on a card. Each individual member of the group will then be given specific task to work/study. His/her expert name attached to the study note that is given to him/her. Each expert is asked to study his/her task for some time. No student in the same group was allowed to see the task given to his fellow group member. Students studying the same task from each group will then be asked to form expert

groups where they study collectively the task and record useful information or the worksheet earlier provided for the purpose of the feedback to his/her jigsaw group.

Step 2. Activity: the activity outlines for expert groups (EPG) are as follows;

EPG A. Members of this group discussed the meaning of functional group

EPG B. Members of this group discussed the Identification of functional group in a given Compounds

EPG C. Members of this group discussed the Meaning of homologous series

EPG D. Members of this group discussed the characteristics of homologous series

EPG E. Members of this group discussed on the general molecular formula of; alkanes, alkenes, alkynes and alcohol

Step 3. Expert Group Discussions

Expert groups are formed by having one student from each JigsawIV group to join other students assigned to the same segment. Students in these expert groups are given time to discuss the main points of their segment and to rehearse the presentations they make in their jigsaw group. The teacher goes round supporting the students.

Step 4. Discussion of their learning outcomes (Home Group Discussion)

Members of the expert groups are after sometime be asked to break and go back to their main group known as jigsaw groups where each expert explains his/her task to the remaining member of his/her group. Other members of the group were encouraged to ask questions and clarification from the expert group where necessary. As the group discussion is on, members of the groups assigned to perform certain role like the time keeper, questioner, reader, reminder and so on does the job.

Activity 1: work sheet for EPG A

Define functional group

_____

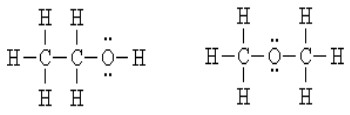
_____

_____

_____

Activity 2: work sheet for EPG B

Identified the functional group in the following compound



CH_3-CH_2-CO-NH_2 CH_3-CH_2-COOH

I II III IV

I ----------

II----------

III----------

IV----------

Activity 3: work sheet for EPG C

Briefly explain the meaning of homologous series

_____

_____

_____

_____

_____

Activity 4: work sheet for EPG D

State any four (4) Characteristics of Homologous series

1._____

2._____

3._____

4._____

Activity 5: work sheet for EPG E

What is the general molecular formula of the following?

1. Alkanes_____

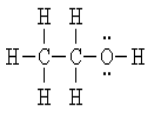
2. Alkenes_____

3. Alkynes_____

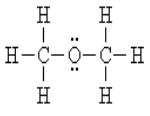
4. Alcohol_____

Evaluation: The researcher evaluates the lesson by given the students following quiz to answer individually:

1. What is hydrocarbon?
2. Identify the functional group in the following compounds



I



II

CH_3-CH_2-CO-NH_2

III

CH_3-CH_2-COOH

IV

3. Briefly explain the meaning of homologous series
4. State any four characteristics of homologous series.
5. What is the general molecular formula of the following?
   a) Alkanes (b) alkenes (c) alkynes (d) Alcohols

The teacher will collect the answers to the question, mark and score it for each student and return them during the next lesson.

Conclusion: The teacher concludes the lesson by re-teaching the main idea or missing part of the lesson.

LESSON PLAN THREE:

Subject: **Chemistry**

Topic: **Alkanes**

Group: **Experimental**

Class: **SSII**

Age: **16-17 years**

Sex: **Mixed (boys and girls)**

Main activity: **Studying the meaning, few members of alkanes, nomenclature of alkanes physical properties, chemical properties and uses of alkanes**

Teaching Model: **Jigsaw IV Cooperative Learning Strategy (Jigsaw model)**

Materials:

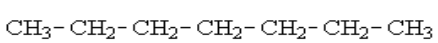
- ❖ Worksheets for all student: Alkanes
- ❖ Copies of study notes to all expert students on :
- ❖ Meaning of alkanes and the first ten member of alkanes
- ❖ Nomenclature of alkanes
- ❖ Physical properties of alkanes
- ❖ Chemical properties of alkanes
- ❖ Uses of alkanes

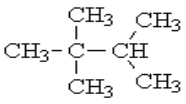
Objectives:

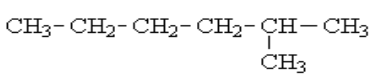
Cognitive: at the end of the lesson the students should be able to:

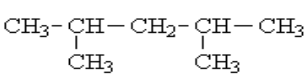
a. Briefly explain meaning of alkanes and the first ten member of alkanes

b. Name the following alkanes compound

(a) 

(b) 

(c) 

(d) 

c. Mention four physical properties of alkanes

d. Enumerate any four chemical properties of alkanes

e. State any four uses of hydrocarbon

Affective: the students should be able to work cooperatively in a jigsaw group

Entry Behaviour : The students were taught Homologous series/ Functional group

Roles Assign to group members

Organizer: Collect group files containing materials; Distribute material to group members; Return materials to the files then to the teacher (researcher)

Reader: Reads the group task to the members

Timer: Keeps track of time; makes sure everyone contributes to answer the question

Encourager: Encourages group members; Decides on the order for the members to read the Task.

Introduction

The teacher introduces the lesson by explaining to the student that they are going to learn hydrocarbon using Jigsaw IV Cooperative learning strategy where all of them will work cooperatively together, and that the success of the group depend on the success of the individual member of the group.

Presentation:

The teacher presents the lesson through the following steps

Step 1. Assigning students into Groups

The teacher then groups the students into a Jigsaw cooperative learning groups comprising of five students per group. Making sure the groups are heterogeneous. Each student in a group is to be assigned a different task to perform. To begin the lesson, the teacher gives each group name written on a card. Each individual member of the group will then be given specific task to work/study. His/her expert name attached to the study

note that is given to him/her. Each expert is asked to study his/her task for some time. No student in the same group was allowed to see the task given to his fellow group member. Students studying the same task from each group will then be asked to form expert groups where they study collectively the task and record useful information or the worksheet earlier provided for the purpose of the feedback to his/her jigsaw group.

Step 2. Activity: the activity outlines for expert groups (EPG) are as follows;

EPG A. Members of this group briefly explained the meaning of alkanes and the first ten member of alkanes series

EPG B. Members of this group discussed names of the following alkanes' compound

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

(b) $CH_3-C(CH_3)(CH_3)-CH(CH_3)-CH_3$

(c) $CH_3-CH_2-CH_2-CH_2-CH(CH_3)-CH_3$

(d) $CH_3-CH(CH_3)-CH_2-CH(CH_3)-CH_3$

EPG C. Members of this group discussed the physical properties of alkanes

EPG D. Members of this group discussed the chemical properties of alkanes

EPG E. Members of this group discussed the uses of alkenes

Step 3. Expert Group Discussions

Expert groups are formed by having one student from each JigsawIV group to join other students assigned to the same segment. Students in these expert groups are given time to discuss the main points of their segment and to rehearse the presentations they make in their jigsaw group. The teacher goes round supporting the students.

Step 4. Discussion of their learning outcomes (Home Group Discussion)

Members of the expert groups are after sometime be asked to break and go back to their main group known as jigsaw groups where each expert explains his/her task to the remaining member of his/her group. Other members of the group were encouraged to ask questions and clarification from the expert group where necessary. As the group

discussion is on, members of the groups assigned to perform certain role like the time keeper, questioner, reader, reminder and so on does the job.

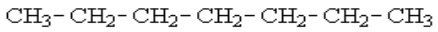
Activity 1: work sheet for EPG A

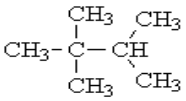
Briefly explain the meaning of alkanes

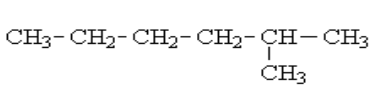
_____
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_____

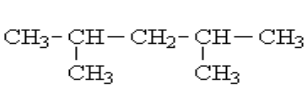
Activity 2: work sheet for EPG B

Name the following alkanes compound

(a) 

(b) 

(c) 

(d) 

a._____
b_____
c_____
d_____

Activity 3: work sheet for EPG C

Mention four physical properties of alkanes

1._____
_____
2._____
_____
3._____
4._____
_____

Activity 4: work sheet for EPG D

Enumerate any four chemical properties of alkanes

1._____
_____

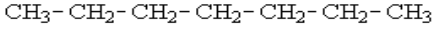
2._____
_____
3._____
4._____
_____

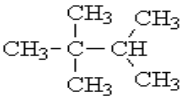
Activity 5: work sheet for EPG E

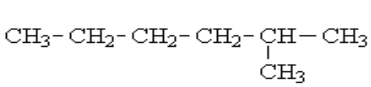
Highlight any four uses of alkanes
1._____
2._____
3._____
4._____

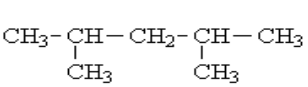
Evaluation: The researcher evaluates the lesson by given the students following quiz to answer individually:

1. What are alkanes?
2. Name the following alkanes compound

(a) 

(b) 

(c) 

(d) 

3. Mention any four physical properties of alkanes
4. Enumerate any four chemical properties of alkanes
5. Mention any four uses of alkanes

The teacher collects the answers to the question, marked and scored it for each student and returned them during the next lesson.

Conclusion: The teacher concludes the lesson by re-teaching the main idea or missing part of the lesson.

LESSON PLAN FOUR:

Subject: **Chemistry**

Topic: **Alkenes**

Group: **Experimental**

Class: **SSII**

Age: **16-17 years**

Sex: **Mixed (boys and girls)**

Main activity: **Studying the meaning, few members of alkenes, nomenclature of alkenes physical properties, chemical properties and uses of alkenes**

Teaching Model: **Jigsaw IV Cooperative Learning Strategy (Jigsaw model)**

Materials:

- Worksheets for all student: Alkenes
- Copies of study notes to all expert students on :
- Meaning of alkanes and the first ten member of alkenes
- Nomenclature of alkenes
- Physical properties of alkenes
- Chemical properties of alkenes
- Uses of alkenes

Objectives:

Cognitive: at the end of the lesson the students should be able to:

i. Briefly explain meaning of alkenes and the first ten member of alkenes

ii. Name the following alkenes compound

(a) $CH_3C(CH_3)CH_2C(CH_3)=CH_2$

(b) $(CH_3)_3CCH=CHCH_3$

(c) $CH_3CH=CHCH_2CH_3$

(d) $CH_3C(CH_3)CH=C(CH_3)CH_3$

iii. Mention four physical properties of alkenes

iv. Enumerate any four chemical properties of alkenes

v. State any four uses of alkenes

Affective: the students should be able to work cooperatively in a jigsaw group

Entry Behaviour: The students were taught alkanes.

Roles Assign to group members

Organizer: Collect group files containing materials; Distribute material to group members; Return materials to the files then to the teacher (researcher)

Reader: Reads the group task to the members

Timer: Keeps track of time; makes sure everyone contributes to answer the question

Encourager: Encourages group members; Decides on the order for the members to read the Task.

Introduction

The teacher introduces the lesson by explaining to the student that they are going to learn hydrocarbon using Jigsaw IV Cooperative learning strategy where all of them will work cooperatively together, and that the success of the group depend on the success of the individual member of the group.

Presentation:

The teacher presents the lesson through the following steps;

Step 1. Assigning students into Groups

The teacher then groups the students into a Jigsaw cooperative learning groups comprising of five students per group. Making sure the groups are heterogeneous. Each student in a group is to be assigned a different task to perform. To begin the lesson, the teacher gives each group name written on a card. Each individual member of the group will then be given specific task to work/study. His/her expert name attached to the study note that is given to him/her. Each expert is asked to study his/her task for some time. No

student in the same group was allowed to see the task given to his fellow group member. Students studying the same task from each group will then be asked to form expert groups where they study collectively the task and record useful information or the worksheet earlier provided for the purpose of the feedback to his/her jigsaw group.

Step 2. Activity: the activity outlines for expert groups (EPG) are as follows;

EPG A. Members of this group briefly explained meaning of alkenes and the first ten member of alkenes series

EPG B. Members of this group discussed the name of the following alkenes compound

(a) $CH_3C(CH_3)CH_2C(CH_3)=CH_2$

(b) $(CH_3)_3CCH=CHCH_3$

(c) $CH_3CH=CHCH_2CH_3$

(d) $CH_3C(CH_3)CH=C(CH_3)CH_3$

EPG C. Members of this group discussed the physical properties of alkenes

EPG D. Members of this group discussed the chemical properties of alkenes

EPG E. Members of this group discussed the uses of alkenes

Step 3. Expert Group Discussions

Expert groups are formed by having one student from each JigsawIV group to join other students assigned to the same segment. Students in these expert groups are given time to discuss the main points of their segment and to rehearse the presentations they make in their jigsaw group. The teacher goes round supporting the students.

Step 4. Discussion of their learning outcomes (Home Group Discussion)

Members of the expert groups are after sometime be asked to break and go back to their main group known as jigsaw groups where each expert explains his/her task to the remaining member of his/her group. Other members of the group were encouraged to ask questions and clarification from the expert group where necessary. As the group

discussion is on, members of the groups assigned to perform certain role like the time keeper, questioner, reader, reminder and so on does the job.

Activity 1: work sheet for EPG A

Briefly explain the meaning of alkenes

_____
_____
_____
_____
_____

Activity 2: work sheet for EPG B

Name the following alkenes compound

(a) $CH_3C(CH_3)CH_2C(CH_3)=CH_2$

(b) $(CH_3)_3CCH=CHCH_3$

(c) $CH_3CH=CHCH_2CH_3$

(d) $CH_3C(CH_3)CH=C(CH_3)CH_3$

a._____
b_____
c_____
d_____

Activity 3: work sheet for EPG C

Mention four physical properties of alkenes

1._____
_____
2._____
_____
3._____
4._____
_____

Activity 4: work sheet for EPG D

Enumerate any four chemical properties of alkenes

1._____
_____

2._____
_____
3._____
4._____
_____

Activity 5: work sheet for EPG E

Highlight any four uses of alkenes
1._____
2._____
3._____
4._____

Evaluation: The researcher evaluates the lesson by given the students following quiz to answer individually:

1. What are alkenes?
2. Name the following alkenes compound

   (a) $CH_3C(CH_3)CH_2C(CH_3)=CH_2$

   (b) $(CH_3)_3CCH=CHCH_3$

   (c) $CH_3CH=CHCH_2CH_3$

   (d) $CH_3C(CH_3)CH=C(CH_3)CH_3$
3. Mention any four physical properties of alkenes
4. Enumerate any four chemical properties of alkenes
5. Mention any four uses of alkenes

The teacher collects the answers to the question, marked and scored it for each student and returned them during the next lesson.

Conclusion: The teacher concludes the lesson by re-teaching the main idea or missing part of the lesson.

LESSON PLAN FIVE:

Subject: **Chemistry**

Topic: **Alkynes**

Group: **Experimental**

Class: **SSII**

Age: **16-17 years**

Sex: **Mixed (boys and girls)**

Main activity: **Studying the meaning, few members of alkynes, nomenclature of alkynes physical properties, chemical properties and uses of alkynes**

Teaching Model: **Jigsaw IV Cooperative Learning Strategy (Jigsaw model)**

Materials:

- Worksheets for all student: Alkynes
- Copies of study notes to all expert students on :
- Meaning of alkynes and the first ten member of alkynes
- Nomenclature of alkynes
- Physical properties of alkynes
- Chemical properties of alkynes
- Uses of alkynes

Objectives:

Cognitive: at the end of the lesson the students should be able to:

i. Briefly explain meaning of alkynes and the first ten member of alkanes

ii. Name the following alkynes compound

(a) $CH_3CH_2CH_3CH(CH_3)C\equiv CH$

(b) $HC\equiv CCH_2CH(CH_3)CH_3$

(c) $CH_3CH_3CH(CH_3)CH_2C\equiv CH$

(d) $CH_3CH_2CH_2CH(CH_3)CH_2C\equiv CH$

iii. Mention four physical properties of alkynes

iv. Enumerate any four chemical properties of alkynes

v. State any four uses of alkynes

Affective: the students should be able to work cooperatively in a jigsaw group

Entry Behaviour: Student were taught alkenes.

Roles Assign to group members

Organizer: Collect group files containing materials; Distribute material to group members; Return materials to the files then to the teacher (researcher)

Reader: Reads the group task to the members

Timer: Keeps track of time; makes sure everyone contributes to answer the question

Encourager: Encourages group members; Decides on the order for the members to read the Task

Introduction

The teacher introduces the lesson by explaining to the student that they are going to learn hydrocarbon using Jigsaw IV Cooperative learning strategy where all of them will work cooperatively together, and that the success of the group depend on the success of the individual member of the group.

Presentation:

The teacher presents the lesson through the following steps

Step 1. Assigning students into Groups

The teacher then groups the students into a Jigsaw cooperative learning groups comprising of five students per group. Making sure the groups are heterogeneous. Each student in a group is to be assigned a different task to perform. To begin the lesson, the teacher gives each group name written on a card. Each individual member of the group will then be given specific task to work/study. His/her expert name attached to the study

note that is given to him/her. Each expert is asked to study his/her task for some time. No student in the same group was allowed to see the task given to his fellow group member. Students studying the same task from each group will then be asked to form expert groups where they study collectively the task and record useful information or the worksheet earlier provided for the purpose of the feedback to his/her jigsaw group.

Step 2. Activity: the activity outlines for expert groups (EPG) are as follows;

EPG A. Members of this group briefly explained meaning of alkynes and the first ten member of alkynes series

EPG B. Members of this group named the following alkynes compound

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

(c) $CH_3CH_3CH(CH_3)CH_2C\equiv CH$ (d) $CH_3CH_2CH_2CH(CH_3)CH_2C\equiv CH$

EPG C. Members of this group discussed the physical properties of alkynes

EPG D. Members of this group discussed the chemical properties of alkynes

EPG E. Members of this group discussed the uses of alkynes

Step 3. Expert Group Discussions

Expert groups are formed by having one student from each JigsawIV group to join other students assigned to the same segment. Students in these expert groups are given time to discuss the main points of their segment and to rehearse the presentations they make in their jigsaw group. The teacher goes round supporting the students.

Step 4. Discussion of their learning outcomes (Home Group Discussion)

Members of the expert groups are after sometime be asked to break and go back to their main group known as jigsaw groups where each expert explains his/her task to the remaining member of his/her group. Other members of the group were encouraged to ask questions and clarification from the expert group where necessary. As the group

discussion is on, members of the groups assigned to perform certain role like the time keeper, questioner, reader, reminder and so on does the job.

Activity 1: work sheet for EPG A

Briefly explain the meaning of alkynes and mention the first 10 members of alkynes

_____
_____
_____
_____
_____
_____

Activity 2: work sheet for EPG B

Name the following alkynes compound

(a) $CH_3CH_2CH_3CH(CH_3)C\equiv CH$ (b) $HC\equiv CCH_2CH(CH_3)CH_3$
(c) $CH_3CH_3CH(CH_3)CH_2C\equiv CH$ (d) $CH_3CH_2CH_2CH(CH_3)CH_2C\equiv CH$

a._____
b_____
c_____
d_____

Activity 3: work sheet for EPG C

Mention four physical properties of alkynes

1._____
_____
2._____
_____
3._____
4._____
_____
_____

Activity 4: work sheet for EPG D

Enumerate any four chemical properties of alkynes

1._____
_____
2._____
_____
3._____

4._____
_____

Activity 5: work sheet for EPG E

Highlight any four uses of alkynes

1._____
2._____
3._____
4._____

Evaluation: The researcher evaluates the lesson by given the students following quiz to answer individually:

a) What are alkynes?

b) Name the following alkynes compound

(a) $CH_3CH_2CH_3CH(CH_3)C\equiv CH$ (b) $HC\equiv CCH_2CH(CH_3)CH_3$
(c) $CH_3CH_3CH(CH_3)CH_2C\equiv CH$ (d) $CH_3CH_2CH_2CH(CH_3)CH_2C\equiv CH$

c) Mention any four physical properties of alkynes

d) Enumerate any four chemical properties of alkynes

e) Mention any four uses of alkynes

The teacher collects the answers to the questions, marks and scored for each student and returns them during the next lesson.

Conclusion: The teacher concludes the lesson by re-teaching the main idea or missing part of the lesson.

LESSON PLAN SIX:

Subject: **Chemistry**

Topic: **Test to identify alkenes and alkynes**

Group: **Experimental**

Class: **SSII**

Age: **16-17 years**

Sex: **Mixed (boys and girls)**

Main activity: **Test of unsaturation for the identification of alkenes and alkynes, distinction between alkene, terminal alkyne and internal alkyne**

Teaching Model: **Jigsaw IV Cooperative Learning Strategy (Jigsaw model)**

Materials:

- Worksheets for all student: Alkynes
- Copies of study notes to all expert students on :
- Distinction between alkene and alkyne
- Distinction between terminal alkyne and internal alkyne

Objectives:

Cognitive: at the end of the lesson the students should be able to:

i. Identify any two differences between alkenes and alkynes

ii. Differentiate between terminal alkynes and internal alkynes

iii. What colour is observed when (a) Br_2/CCl_4 (b) Dilute $KMnO_4$ (c) $Ag(NH_3)_2^+$ OH^- is added to alkene, alkyne, terminal alkyne and internal alkyne

Affective: the students should be able to work cooperatively in a jigsaw group

Entry Behaviour: Students were taught alkanes, alkenes and alkynes

Roles Assign to group members

Organizer: Collect group files containing materials; Distribute material to group members; Return materials to the files then to the teacher (researcher)

Reader: Reads the group task to the members

Timer: Keeps track of time; makes sure everyone contributes to answer the question

Encourager: Encourages group members; Decides on the order for the members to read the Task

Introduction

The teacher introduces the lesson by explaining to the student that they are going to learn hydrocarbon using Jigsaw IV Cooperative learning strategy where all of them will work cooperatively together, and that the success of the group depend on the success of the individual member of the group.

Presentation:

The teacher presents the lesson through the following steps;

Step 1. Assigning students into Groups

The teacher then groups the students into a Jigsaw cooperative learning groups comprising of five students per group. Making sure the groups are heterogeneous. Each student in a group is to be assigned a different task to perform. To begin the lesson, the teacher gives each group name written on a card. Each individual member of the group will then be given specific task to work/study. His/her expert name attached to the study note that is given to him/her. Each expert is asked to study his/her task for some time. No student in the same group was allowed to see the task given to his fellow group member. Students studying the same task from each group will then be asked to form expert groups where they study collectively the task and record useful information or the worksheet earlier provided for the purpose of the feedback to his/her jigsaw group.

Step 2. Activity: the activity outlines for expert groups (EPG) are as follows;

EPG A. Members of this group explained the two test used to identify alkene and alkyne.

EPG B. Members of this group Differentiate between alkene, terminal alkyne and internal alkyne

EPG C. Members of this group identified colour observed when (a) Br_2/CCl_4 (b) Dilute $KMnO_4$ (c) $Ag(NH_3)_2^+ OH^-$ is added to alkene, terminal alkyne and internal alkyne

Step 3. Expert Group Discussions

Expert groups are formed by having one student from each JigsawIV group to join other students assigned to the same segment. Students in these expert groups are given time to discuss the main points of their segment and to rehearse the presentations they make in their jigsaw group. The teacher goes round supporting the students.

Step 4. Discussion of their learning outcomes (Home Group Discussion)

Members of the expert groups are after sometime be asked to break and go back to their main group known as jigsaw groups where each expert explains his/her task to the remaining member of his/her group. Other members of the group were encouraged to ask questions and clarification from the expert group where necessary. As the group discussion is on, members of the groups assigned to perform certain role like the time keeper, questioner, reader, reminder and so on does the job.

Activity 1: work sheet for EPG A

Explained two test used identify alkene and alkyne

1_____
_____
_____
2_____
_____
_____

Activity 2: work sheet for EPG B

Differentiate between alkene, terminal alkyne and internal alkyne

_____
_____
_____
_____
_____
_____
_____
_____
_____

Activity 3: work sheet for EPG C

What colour is observed when (a) Br_2/CCl_4 (b) Dilute $KMnO_4$ (c) $Ag(NH_3)_2^+ OH^-$ is added to alkene, alkyne, terminal alkyne and internal alkyne

a._____

b_____

c._____

Evaluation: The researcher evaluates the lesson by given the students following quiz to answer individually:

a) What are the two test used in identification of alkene and alkyne?

b) Differentiate between terminal alkyne and internal alkyne

c) What colour is observed when (a) Br_2/CCl_4 (b) Dilute $KMnO_4$ (c) $Ag(NH_3)_2^+ OH^-$ is added to alkene, alkyne, terminal alkyne and internal alkyne

The teacher collects the answers to the questions, marks and scored for each student and returns them during the next lesson.

Conclusion: The teacher concludes the lesson by re-teaching the main idea or missing part of the lesson and informed the students that they would write test next week.

APPENDIX B

SAMPLE LESSON PLANS FOR CONTROL GROUP

LESSON PLAN ONE:

Subject: **Chemistry**

Topic: **Hydrocarbon**

Group: **Control**

Class: **SSII**

Age: **16-17 years**

Sex: **Mixed (boys and girls)**

Main activity: **Studying the meaning, classes, sources and uses of hydrocarbons**

Teaching Model: **Lecture Method**

Materials: **Lesson note and chalk**

Objectives: at the end of the lesson the 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

Entry Behaviour: Students were taught periodic table and they can identify the position of Hydrogen and carbon in the periodic table.

Presentation:

- The teacher presents the lesson by reviewing the first twenty element of the periodic table, with the emphases on the position of Carbon and Hydrogen.
- The meaning of Hydrocarbon was explained
- The classes of Hydrocarbon
- Properties of Hydrocarbon
- Sources of Hydrocarbon and

- ❖ Uses of hydrocarbon were also explained

Evaluation: the following questions were asked to evaluate learning outcomes.

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

Summary: The teacher summarizes the lesson: thus hydrocarbons are compounds containing carbon and hydrogen only. The two classes of hydrocarbon are aliphatic and aromatic and so on.

Conclusion: the teacher concludes the lesson by given the student take home assignment to be submitted next class.

LESSON PLAN TWO:

Subject: **Chemistry**

Topic: **Functional group/ Homologous series**

Group: **Control**

Class: **SSII**

Age: **16-17 years**

Sex: **Mixed (boys and girls)**

Main activity: **Studying the meaning of functional group, Homologous series, their characteristics, identification of functional group in a given compounds**

Teaching Model: **Lecture Method**

Materials: **Lesson note and chalk**

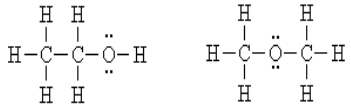
Objectives: at the end of the lesson the students should be able to:

a. Define Functional group
b. Identify the functional group in a given compounds
c. Explain the meaning of homologous series
d. Mention any four characteristics of homologous series
e. What are the general molecular formula of the following; alkanes, alkenes, alkynes and alcohol

Entry Behaviour: Students were taught hydrocarbons.

Presentation:

- The teacher presents the lesson by reviewing the previous lesson on Hydrocarbon.
- The meaning of functional group
- Identify the functional group of the following compounds



CH_3-CH_2-CO-NH_2 CH_3-CH_2-COOH

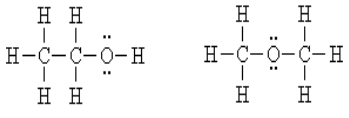
I II III IV

- ❖ meaning of homologous series
- ❖ Mention any four characteristics of homologous series
- ❖ Write the general molecular formula of the following; alkanes, alkenes, alkynes and alcohol

Evaluation: the following questions were asked to evaluate learning outcomes.

a. What is functional group?

b. Identify the functional group in the following compounds



I II

CH_3-CH_2-CO-NH_2 III

CH_3-CH_2-COOH IV

c. Briefly explain the meaning of homologous series

d. State any four characteristics of homologous series.

e. What is the general molecular formula of the following?

b) Alkanes (b) alkenes (c) alkynes (d) Alcohols

Summary: The teacher summarizes the lesson: thus functional group is an atom or group of atoms that can determine the physical and chemical properties of organic molecules. Homologous series are series of compound bonded together by a general molecular formula and each member differ from the next by $–CH_2$. And so on.

Conclusion: the teacher concludes the lesson by given the student take home assignment to be submitted next class.

LESSON PLAN THREE:

Subject: **Chemistry**

Topic: **Alkanes**

Group: **Control**

Class: **SSII**

Age: **16-17 years**

Sex: **Mixed (boys and girls)**

Main activity: **Studying the meaning, few members of alkanes, nomenclature of alkanes physical properties, chemical properties and uses of alkanes**

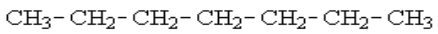
Teaching Model: **Lecture Method**

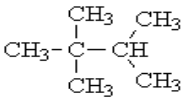
Materials: **Lesson note and chalk**

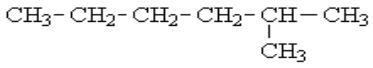
Objectives: at the end of the lesson the students should be able to:

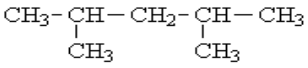
a. Briefly explain meaning of alkanes and the first ten member of alkanes

b. Name the following alkanes compound

(a) 

(b) 

(c) 

(d) 

c. Mention four physical properties of alkanes

d. Enumerate any four chemical properties of alkanes

e. State any four uses of alkanes

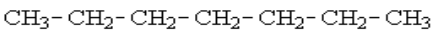
Entry Behaviour: Students were taught homologous series/ functional group.

Presentation:

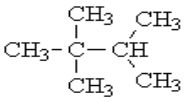
- The teacher presents the lesson by reviewing the previous lesson on Homologous series/ functional group.

- Briefly explain meaning of alkanes and the first ten member of alkanes
- Name the following alkanes compound

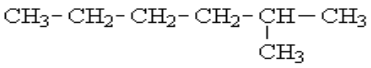
(a)



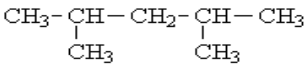
(b)



(c)



(d)

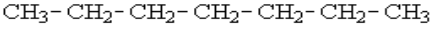


- Mention four physical properties of alkanes
- Enumerate any four chemical properties of alkanes
- State any four uses of hydrocarbon

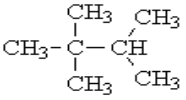
Evaluation: the following questions were asked to evaluate learning outcomes.

1. What are alkanes?
2. Name the following alkanes compound

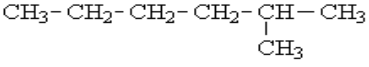
(a)



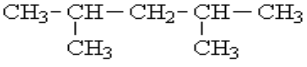
(b)



(c)



(d)



3. Mention any four physical properties of alkanes
4. Enumerate any four chemical properties of alkanes
5. Mention any four uses of alkanes

Summary: The teacher summarizes the lesson on alkanes

Conclusion: the teacher concludes the lesson by given the student take home assignment to be submitted next class.

LESSON PLAN FOUR:

Subject: **Chemistry**

Topic: **Alkenes**

Group: **Control**

Class: **SSII**

Age: **16-17 years**

Sex: **Mixed (boys and girls)**

Main activity: **Studying the meaning, few members of alkenes, nomenclature of alkenes physical properties, chemical properties and uses of alkenes**

Teaching Model: **Lecture Method**

Materials: **Lesson note and chalk**

Objectives: at the end of the lesson the students should be able to:

i. Briefly explain meaning of alkenes and the first ten member of alkenes
ii. Name the following alkenes compound
    (a) $CH_3C(CH_3)CH_2C(CH_3)=CH_2$
    (b) $(CH_3)_3CCH=CHCH_3$
    (c) $CH_3CH=CHCH_2CH_3$
    (d) $CH_3C(CH_3)CH=C(CH_3)CH_3$
iii. Mention four physical properties of alkenes
iv. Enumerate any four chemical properties of alkenes
v. State any four uses of alkene

Entry Behaviour: Students were taught alkanes

Presentation:

- the teacher will present the lesson by reviewing the previous lesson on alkanes
- Briefly explain meaning of alkenes and the first ten member of alkenes

- Name the following alkenes compound

  (a) $CH_3C(CH_3)CH_2C(CH_3)=CH_2$

  (b) $(CH_3)_3CCH=CHCH_3$

  (c) $CH_3CH=CHCH_2CH_3$

  (d) $CH_3C(CH_3)CH=C(CH_3)CH_3$
- Mention four physical properties of alkenes
- Enumerate any four chemical properties of alkenes
- State any four uses of alkene

Evaluation: the following questions were asked to evaluate learning outcomes.

i. What are alkenes?

ii. Name the following alkanes compound

(a) $CH_3C(CH_3)CH_2C(CH_3)=CH_2$

(b) $(CH_3)_3CCH=CHCH_3$

(c) $CH_3CH=CHCH_2CH_3$

(d) $CH_3C(CH_3)CH=C(CH_3)CH_3$

iii. Mention any four physical properties of alkenes

iv. Enumerate any four chemical properties of alkenes

v. Mention any four uses of alkenes

Summary: The teacher summarizes the lesson on alkenes

Conclusion: the teacher concludes the lesson by given the student take home assignment to be submitted next class.

LESSON PLAN FIVE:

Subject: **Chemistry**

Topic: **Alkynes**

Group: **Control**

Class: **SSII**

Age: **16-17 years**

Sex: **Mixed (boys and girls)**

Main activity: **Studying the meaning, few members of alkynes, nomenclature of alkynes physical properties, chemical properties and uses of alkynes**

Teaching Model: **Lecture Method**

Materials: **Lesson note and chalk**

Objectives: at the end of the lesson the students should be able to:

i. Briefly explain meaning of alkynes and the first ten member of alkynes

ii. Name the following alkenes compound

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

(c) $CH_3CH_3CH(CH_3)CH_2C\ CH$ (d) $CH_3CH_2CH_2CH(CH_3)CH_2C\ CH$

iii. Mention four physical properties of alkynes

iv. Enumerate any four chemical properties of alkynes

v. State any four uses of alkyne

Presentation: Students were taught alkenes

- The teacher presents the lesson by reviewing the previous lesson on alkynes
- Briefly explain meaning of alkynes and the first ten member of alkynes
- Name the following alkynes compound

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

(c) $CH_3CH_3CH(CH_3)CH_2C{\equiv}\ CH$ (d) $CH_3CH_2CH_2CH(CH_3)CH_2C{\equiv}\ CH$

- Mention four physical properties of alkynes

- ❖ Enumerate any four chemical properties of alkynes
- ❖ State any four uses of alkyne

Evaluation: the following questions were asked to evaluate learning outcomes.

- **i.** What are alkynes?
- **ii.** Name the following alkynes compound

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

  (c) $CH_3CH_3CH(CH_3)CH_2C\equiv CH$ (d) $CH_3CH_2CH_2CH(CH_3)CH_2C\equiv CH$
- **iii.** Mention any four physical properties of alkynes
- **iv.** Enumerate any four chemical properties of alkynes
- **v.** Mention any four uses of alkynes

Summary: The teacher summarizes the lesson on alkynes

Conclusion: the teacher concludes the lesson by given the student take home assignment to be submitted next class.

LESSON PLAN SIX:

Subject: **Chemistry**

Topic: **Test to identify alkenes and alkynes**

Group: **Control**

Class: **SSII**

Age: **16-17 years**

Sex: **Mixed (boys and girls)**

Main activity: **test of unsaturation for the identification of alkenes and alkynes, distinction between alkene, terminal alkyne and internal alkyne**

Teaching Model: **Lecture Method**

Materials: **Lesson note and chalk**

Objectives: at the end of the lesson the students should be able to:

i. Identify any two differences between alkene and alkyne

ii. Differentiate between terminal alkyne and internal alkyne

iii. What colour is observed when (a) Br_2/CCl_4 (b) Dilute $KMnO_4$ (c) $Ag(NH_3)_2^+$ OH^- is added to alkene, alkyne, terminal alkyne and internal alkyne

Entry Behaviour: Students were taught alkanes, alkenes and alkynes

Presentation:

- the teacher presents the lesson by reviewing the previous lesson on alkynes
- mention two test to identify alkene and alkyne
- differentiate between alkene and alkyne, terminal alkyne and internal alkyne
- identify colour observed when (a) Br_2/CCl_4 (b) Dilute $KMnO_4$ (c) $Ag(NH_3)_2^+$ OH^- is added to alkene, alkyne, terminal alkyne and internal alkyne

Evaluation: the following questions were asked to evaluate learning outcomes.

a) What are the two test used in identification of alkene and alkyne?

b) Differentiate between terminal alkyne and internal alkyne

c) What colour is observed when (a) Br_2/CCl_4 (b) Dilute $KMnO_4$ (c) $Ag(NH_3)_2^+ OH^-$ is added to alkene, alkyne, terminal alkyne and internal alkyne

Summary: The teacher summarizes the lesson on test for alkene and alkyne

Conclusion: the teacher concludes the lesson by informing students that there would be test next class.

APPENDIX C

ORGANIC CHEMISTRY PERFORMANCE TEST

Dear Respondent,

This Chemistry Performance Test is meant for collection of data for Master's degree in Chemistry Education of Department of Science Education, Ahmadu Bello University Zaria. It is designed to help in finding students' performance and retention of Organic Chemistry concepts in Zaria educational zone, Kaduna, Nigeria. All information provided will be kept confidential and will be used only for the purpose of this study. Therefore your honest response is hereby required.

Thanks.

INSTRUCTIONS:

This test consists of 40 objective items. Each question is followed by alternative responses lettered a-d. You are expected to choose and circle the correct responses for each question. Each question carries equal marks.

Name……Sex……School……
…….Time: 120 minutes

1. Organic chemistry is defined as the chemistry of
   (a) hydrocarbon only
   (b) hydrocarbon and its derivatives
   (c) carbon only
   (d) carbon and its compounds.
2. 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) combines with hydrogen, oxygen, nitrogen and halogens
   (c) form single, double or triple covalent bonds
   (d) combine with every element.
3. Hydrocarbons are compounds containing

(a) carbon and nitrogen only

(b) carbon only

(c) carbon, hydrogen and oxygen

(d) carbon and hydrogen only.

4. The balanced equation for the combustion of pentane is

(a) $4C_5H_{12} + 2O_2 \rightarrow 20CH_4 + 4H_2O$
(b) $2C_3H_8 + O_2 \rightarrow CH_4 + 2H_2O$
(c) $C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$
(d) $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

5. Hydrocarbons can be classified into;

(a) Aliphatic hydrocarbons only

(b) Aliphatic and aromatic hydrocarbons

(c) Aromatic hydrocarbons only

(d) Cyclic hydrocarbons only.

6. Which of the following is a saturated hydrocarbon?

(a) C_2H_6

(b) C_2H_4

(c) C_2H_2

(d) C_3H_6

7. The followings are hydrocarbons **except**

(a) methylpropanol

(b) methylbenzene

(c) benzene

(d) cyclohexane

8. Unsaturation in hydrocarbons is found in

(a) ethane

(b) 2-methylpropane

(c) 2,2,4-trimethylpentane

(d) butyne

9. …… 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

10. A family of organic compounds which follows a regular structural pattern, in which each successive member differs in its molecular formula by a $-CH_2-$ group is known as

(a) functional series

(b) aromatic hydrocarbons

(c) aliphatic hydrocarbons

(d) homologous series.

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

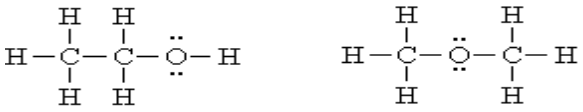
(a) C_2H_4

(b) C_2H_8

(c) C_3H_6

(d) C_3H_8

12. How are the following compounds related?



(a) Isoelectronic species

(b) Isotopes

(c) Isomers

(d)These compounds are not related at all...they are totally different.

13. The two main types of Isomerism are

(a) structural and non-structural

(b) structural and geometric

(c) cis and trans

(d) geometric and non-geometric

14. The names of a homologous series depends on…….

(a) first member of the series

(b) second member of the series families

(c) number of alkyl group series

(d) functional group

15. -CO-NH_2 is the functional group of

(a) amide

(b) amine

(c) aryl- halide

(d) cynide

16. The empirical formula of compound Y is CHO_2. If its relative molecular mass is 90, what is the molecular formula among the following?

(a) $C_2H_2O_2$

(b) $C_2H_2O_4$

(c) $C_4H_4O_8$

(d) $C_2H_4O_4$

17. The functional group of 2-methylpropanoic acid is……

(a) –CONH2

(b) –C=O

(c) -COOH

(d) -CHO

18. 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 increases in the number of carbon atom

(d) All of the above

19. 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

20. The IUPAC name of $(CH_3)_3CCH_2(CH_2)_3CH_3$ is

(a) 1, 1-dimethylheptane

(b) 3-methylheptane

(c) 2,2-dimethylheptane

(d) pentane

21. The following are natural sources of alkanes except

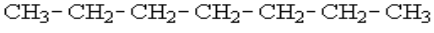
(a) Plant

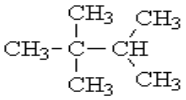
(b) Fungi and Microorganism

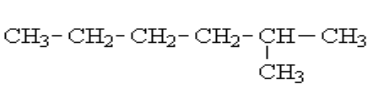
(c) Minerals

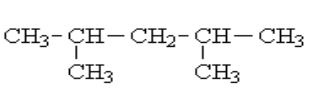
(d) Synthetic reactions

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

(a) 

(b) 

(c) 

(d) 

23. The main chemical property that differentiates methane from ethene is

(a) Hydrogenation

(b) combustion reaction

(c) substitution reaction

(d) addition reaction

24. One of the chemical tests that can distinguish ethane from ethene is that;

(a) ethane decolourise bromine water while ethene does not

(b) ethene decolourise bromine water while ethane does not

(c) ethane give white precipitate with ammoniacal solution while ethane does

not

(d) none of the above

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. Which of the following is an alkene compound?

(a) $C_6H_5CH_3$

(b) $CH_3(CH_2)_4CH_3$

(c) $CH_2CH=CHCH_3$

(d) $CH_3CH_2CH_3$

27. The addition of mineral acids to an alkene result in a product with the nucleophile bonded to the carbon atom that hold the lowest number of hydrogen atom. This statement is in accordance with:

(a)Hooke's law

(b) Boyle's law

(c) Hund's rule

(d) Markownikovs rule

28. In a reaction between CH_3-CH=CH_2 and HBr. The Br will attach to carbon number….
^{3} ^{2} ^{1}
According to the rule in 27 above
(a) 1 (b) 2 (c) 3 (d) none of the above

29. The IUPAC name of $CH_3CH_2CH=CH_2$ is

(a) But-1-ene

(b) But-3-ene

(c) But-4-ene

(d) But-2-ene

30. The structural formula of 2,4-dimethylpent-2-ene is

(a) $CH_3C(CH_3)CH_2C(CH_3)=CH_2$

(b) $(CH_3)_3CCH=CHCH_3$

(c) $CH_3CH=CHCH_2CH_3$

(d) $CH_3C(CH_3)CH=C(CH_3)CH_3$

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

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

32. When ethanol is heated with excess concentrated tetraoxosulphate(VI)acid, the organic product formed is

(a) ethane

(b) ethene

(c) ethyne

(d) butyne

33. Alkynes have the general formula given by…….

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

34. Alkynes are regarded as unsaturated hydrocarbons because of:

(a) The presence of long chain structure

(b) The presence of triple bond in its structure

(c)The absence of pi electron in its structure

(d) The presence of hydrogen atoms in its Structure

35. The structure of 4-methylhex-1-yne is

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

(c) $CH_3CH_3CH(CH_3)CH_2C\equiv CH$ (d) $CH_3CH_2CH_2CH(CH_3)CH_2C\equiv CH$

36. Terminal alkynes give ---------- precipitate with ammoniacal solutions of $AgNO_3$ (a) redish-brown (b) pale yellow (c) white (d) dirty green

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

(a) Hydrogenation

(b) dehydrogenation

(c) hydration

(d) isomerization

38. Ethyne gives reddish-brown precipitates with ammoniacal 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.

39. 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.

40. Alkynes burns with luminous smoky flame because of----------

(a) high carbon content

(b) low carbon content

(c) high hydrogen content

(d) low hydrogen content

APPENDIX D

Organic Chemistry Perception Questionnaire (OCPQ)

Dear Respondent,

This questionnaire is meant for collection of data for Master's degree in Chemistry Education of the Department of Science Education, Ahmadu Bello University Zaria. It is designed to help find students' perception of organic chemistry concepts. All information provided will be kept confidential and be used only for the purpose of this study. Therefore your honest response is hereby required.

Thanks.

Instruction: respond to all questions by ticking appropriate column corresponding to your view.

Section A: Bio Data

1. Name of School:----------
2. Age: 9-11 ( ) 12-14 ( ) 15-17 ( ) 18- above ( )
3. Sex: Male ( ) Female ( )
4. Hobbies: Reading ( ) Travelling ( ) Sports ( ) Games ( ) others ---------- specify
5. Ambition : Pharmacist ( ) Doctor ( ) Engineer ( ) Chemist ( ) Biologist ( ) others --

Section B: Perception of Organic concepts

Besides each statement are possible options of:

Strongly Agree = SA Agree = A Undecided = UD Disagree = D Strongly Disagree = SD

Please tick the statement that best expresses your opinion.

S/N	STATEMENTS	SA	A	UD	D	SD
1	Chemistry is a very interesting subject to me					
2	Organic chemistry is interesting and easy to me					
3	Organic chemistry is interesting but I find it very difficult to understand					
4	I enjoy organic chemistry more than other branches of chemistry					
5	My chemistry teacher makes organic chemistry interesting and fun					
6	My chemistry teacher makes organic chemistry uninteresting and boring					
7	Organic chemistry is a very important branch of chemistry to me					
8	I have heard of organic chemistry before					
9	I have been taught organic chemistry before					
10	The period given to chemistry in a week is enough					
11	Organic Chemistry should be learner-centered					
12	Ability to balance chemical equation makes organic chemistry easier					
13	I have never done any group task in organic chemistry					
14	Exposure to organic chemistry has made me to be critical observant					
15	My organic chemistry teacher always uses lecture method					
16	The best way to learn organic chemistry is to cram the structures and formula					
17	My organic chemistry teacher always engages us in class activities					
18	Students in my class are too many for any organic concept activity to be conducted in group					
19	Organic chemistry concepts are mostly illustrated on the chalkboard					
20	Natural food are organic compounds in nature					
21	Only Hydrocarbons are organic compound					
22	Woods are not organic in nature					
23	other people in the group just keep quiet and do not help us by giving ideas					
24	There are no textbooks for me to learn organic chemistry					

APPENDIX E
MARKING SCHEME FOR ORGANIC CHEMISTRY PERFORMANCE TEST

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

APPENDIX F

RELIABILITY Value of OCPT and OCPQ Respectively

VARIABLES=Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q12 Q13 Q14 Q15 Q16 Q17 Q18 Q19 Q20 Q21 Q22 Q23 Q24 Q25 Q26 Q27 Q28 Q29 Q30 Q31 Q32 Q33 Q34 Q35 Q36 Q37 Q38 Q39 Q40

/SCALE('ALL VARIABLES') ALL

/MODEL=ALPHA

/STATISTICS=SCALE.

RELIABILITY FOR OCPT

Notes

Output Created		13-JUL-2017 07:25:41
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	50
	Matrix Input	
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on all cases with valid data for all variables in the procedure.

Syntax		RELIABILITY /VARIABLES=Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q12 Q13 Q14 Q15 Q16 Q17 Q18 Q19 Q20 Q21 Q22 Q23 Q24 Q25 Q26 Q27 Q28 Q29 Q30 Q31 Q32 Q33 Q34 Q35 Q36 Q37 Q38 Q39 Q40 /SCALE('ALL VARIABLES') ALL /MODEL=ALPHA /STATISTICS=SCALE.
Resources	Processor Time	00:00:00.02
	Elapsed Time	00:00:00.02

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	50	100.0
	Excluded[a]	0	.0
	Total	50	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	No. of Items
.886	40

Scale Statistics

Mean	Variance	Std. Deviation	No. of Items
29.36	36.317	6.026	40

RELIABILITY FOR OCPQ

/VARIABLES=P1 P2 P3 P4 P5 P6 P7 P8 P9 P10 P11 P12 P13 P14 P15 P16 P17 P18 P19 P20 P21 P22 P23 P24 P25

/SCALE('ALL VARIABLES') ALL

/MODEL=ALPHA

/STATISTICS=SCALE

Reliability

		N	%
Cases	Valid	50	100.0
	Excluded[a]	0	.0
	Total	50	100.0

a. List wise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	**No. of Items**
.760	25

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
49.1000	88.908	17.04531	24

APPENDIX G. Table showing Results of Scheffe's Test

	(I) Sample	(J) Sample	Std. Error	Sig.
Scheffe	1	2	1.117	.999
		3	1.268	.000
		4	1.592	.000
		5	1.592	.014
		6	1.785	.000
	2	1	1.117	.999
		3	1.303	.000
		4	1.620	.000
		5	1.620	.007
		6	1.810	.000
	3	1	1.268	.000
		2	1.303	.000
		4	1.727	.973
		5	1.727	.001
		6	1.907	1.000
	4	1	1.592	.000
		2	1.620	.000
		3	1.727	.973
		5	1.977	.085
		6	2.136	.997
	5	1	1.592	.014
		2	1.620	.007
		3	1.727	.001
		4	1.977	.085
		6	2.136	.036
	6	1	1.785	.000
		2	1.810	.000
		3	1.907	1.000
		4	2.136	.997
		5	2.136	.036

APPENDIX H: FI and DI for OCPT and OCPQ

No of Items	FI= $\frac{R}{T} \times 100$ (%)	DI = $\frac{R_{u-R_l}}{N}$
1	54	0.51
2	51	0.52
3	52	0.46
4	57	0.47
5	45	0.45
6	41	0.43
7	49	0.55
8	19	0.29
9	55	0.42
10	46	0.50
11	52	0.54
12	49	0.50
13	50	0.48
14	50	0.49
15	48	0.54
16	46	0.57
17	53	0.51
18	56	0.46
19	46	0.58
20	54	0.54
21	51	0.55
22	44	0.49
23	45	0.58
24	54	0.56
25	49	0.50
26	49	0.51
27	23	0.19
28	51	0.60
29	56	0.44
30	48	0.50
31	45	0.49
32	49	0.50
33	46	0.50
34	44	0.56
35	49	0.49
36	47	0.55
37	56	0.58
38	50	0.49
39	42	0.45
40	44	0.40

APPENDIX I

Department of Science Education
Ahmadu Bello University
Zaria.
12th June, 2017

Dear sir/ Madam,

REQUEST FOR VALIDATION OF INSTRUMENTS

I am a post graduate student of the Department of Science Education (Chemistry).I am carrying out a research study titled; "Effects of Jigsaw IV Cooperative Learning Strategy on Students' Perception, Retention and Academic Performance in Organic Chemistry in Zaria Educational zone, Kaduna, Nigeria".

I humbly request you to critically examine the instruments in terms of clarity of the instrument, clarity of language, appropriateness and adequacy of the terms in measuring what it supposes to measure.

Thanks

Yours Faithfully

Ibrahim Mohammed, ISA
P15EDSC8009