EFFECTS OF GUIDED INQUIRY ON MOTIVATION AND ACADEMIC ACHIEVEMENT IN ORGANIC CHEMISTRY AMONGSECONDARY SCHOOL STUDENTS IN MUSAWA, KATSINA STATE, NIGERIA

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DECLARATION

I hereby declared that this work titled “Effects of Guided Inquiry on MotivationandAcademic Achievement in OrganicChemistryamong Secondary School Students in Musawa, Katsina State,Nigeria”is my research effortcarried out under the supervision of Dr. Suwaiba Sa’id Ahmad and has not been presented anywhere for the award of any degree or certificate. All sources have been duly acknowledged.

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CERTIFICATION

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APPROVAL PAGE

This dissertation titled "Effects of Guided Inquiry on Motivation and Academic Achievement in OrganicChemistry among Secondary School Students in Musawa, Katsina State, Nigeria" by MUHAMMAD Hamza, meets the regulations governing the award of the Degree of Masters in Chemistry Education of Bayero UniversityKano and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This work is dedicated to my parents for their support and contributions given to me and to the entire Muslim Ummah.

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LIST OF ABBREVIATIONS

OCAT =Organic Chemistry Achievement Test

SMRS = Students' Motivation Rating Scale

FME = Federal Ministry of Education

FRN = Federal Republic of Nigeria

SSCE = Secondary School Certificate Examination

SSII = Senior Secondary Two

WAEC = West African Examinations Council

STAN = Science Teachers Association of Nigeria

GIS = Guided Inquiry Strategy

GSSS= Government Science Secondary School

GPSSS= GovernmentPilot Senior Secondary School

NERDC = Nigerian Educational Research and Development Council

EG = Experimental Group

CG = Control Group

$\mathbf{O_1}$ = Pre-Test

$\mathbf{O_2}$ = Post-Test

$\mathbf{X_1}$ = Experimental Treatment (Guided Inquiry)

$\mathbf{X_0}$ = Control Group (Lecture method)

ABSTRACT

This study investigated the Effects of Guided Inquiry on Motivation and Academic Achievement in OrganicChemistry among Secondary School Students in Musawa, Katsina State, Nigeria. To guide the study, four research objectives, four research questions and four corresponding hypotheses were formulated. A quasi-experimental research design involving Pretest and Posttest was used for the study. The sample size comprised of 72 SSII Chemistry students out of a population of 495 students drawn from ten co-educational public schools, two schools in the zone chosen via simple random sampling took part in the study.In each school, intact classes of SSII Science were used. The schools were randomly assigned to experimental and control groups. A 30 items, multiple choice "Organic Chemistry Achievement Test" (OCAT) was adapted from previous WAEC questions and "Students' Motivation Rating Scale" (SMRS) was adapted from Glynn and Koballa (2006). The OCAT & SMRS were validated by three experts,one professor in Science & Technology Education Department,Bayero UniversityKano, one senior lecturer in Chemistry Department at Umaru Musa Yar'adua University Katsina and one experienced Graduate Chemistry teacher with ten years teaching experience at GSSS Dutsinma. The reliability of the instrument OCAT was established using Pearson Product Moment Correlation (PPMC) and yielded a reliability index of 0.80 while that of SMRS was obtained using Cronbach's Alpha with a reliability of 0.70. The Experimental group was taughtHydrocarbons (Alkanes, Alkenes & Alkynes) using guided inquiry strategy and the Control group was taught the same concept using lecture method. The OCAT and SMRS were administered to both groups before and after the treatment as pre-test and post-test. The collected data were analyzed using SPSS Version 20 to answer the research questions usingdescriptive statistics (mean, mean rank and standard deviation) as well as testing the null hypotheses using Z-test and U-test.The analysis of the data revealed that students taught with guided inquiry strategy performedsignificantly better than students taught withlecture method and also the experimental group were more motivated than the control group. The study concluded that guided inquiry strategy enhancedthe academic achievement and motivationof SS II chemistry students in organic chemistry. The study therefore recommends that guided inquirystrategy be adopted in the teaching and learning of chemistryparticularlyorganic chemistry.

CHAPTER ONE
INTRODUCTION

1.1 Background of the Study

The secret of technological development of any nation lies in the study of science. Science has enormous influence on our lives. It provides the basis of modern technology, the tools and techniques, sources and resources of energy that makes our lives easier. Science, according to Lang (2006) covers a broad field of knowledge that deals with observed facts and the relationship among those facts. May and Aikman, (2003) viewed Education as the process of facilitating learning or acquisition of knowledge, skills, values, beliefs and habits. Therefore Education is the process of imparting general knowledge, developing the power of reasoning, judgment and generally of preparing oneself intellectually for mature life. Learning scientific processes and principles that usually lead to fundamental and applied research is referred to as science education (Owolabi, 2007).

According to Adekola (2011), science education can be referred to the transmission and acquisition of the process and product of science as well as their application in solving personal and societal problems. As any educational system, science education fundamental objective are to produce qualified science teachers as well as teaching all students science and cultivating them to be scientifically literate citizens. The need for science and technology as effective tool for a nations' overall sustainable development can hardly be overemphasized because science education leads to national reconstruction and development for self-reliance (Arroio, 2011). Thus the economic and social development of both developed and developing nations like Nigeria are to a large extent dependent on the level of scientific and technological literacy of her citizens. Science and technology education is the factory for the production of the needed technologies, technicians, craftsmen as well as skilled artisans who are required to turn the nations' economy in the desired

technological improvement which is highly required for the advancement of Nigeria from a consumer nation to producer nation (Opara, 2011). Acquisition of appropriate scientific and technological skills is necessary to cope with the existing challenges by the evolving needs of modern work place in our industries and ever growing non-formal sector. It is against this background that science education has been given a prime position worldwide. All branches of science have important contribution to make in a nations' technological advancement.

Within the context of science education, chemistry has been identified as a very important science subject and its importance in scientific and technological development of a nation has been widely reported (Adesoji & Olatunbosun, 2008). However, Jantur (2005) pointed out that chemistry is presumed to be the fulcrum on which all science and technology disciplines hinged for national development. Chemistry as a subject usually taught right from Secondary School up to the tertiary institutions of learning has a central position in Science and Technology. Chemistry is the scientific study of interaction of chemical substances that constitute atoms or sub-atomic particles; protons, electrons and neutrons. It is an integral part of science curriculum (Ojokuku, 2010).

Chemistry occupies a central position among sciences due to its remarkable contribution in medicine, pharmacy, engineering, agriculture, textile industry and petroleum industry to mention but a few. It is a pre-requisite subject for offering most science oriented courses in our tertiary institutions and this calls for the need to teach chemistry effectively so as to convert the available natural resources (such as limestone, coal, diamond, rubber and vegetables among others) to the desired products for optimum use.

Despite the role of chemistry as a central science that forms the basic foundation to many disciplines and in improving the quality of life, students' performance in the subject is still low

(WAEC, 2012). The Science Teachers Association of Nigeria (STAN) has identified these problems of poor performance in chemistry observed among secondary school students that is attributed to some factors which include inadequacy of qualified chemistry teachers, lack of instructional materials, inappropriate use of teaching method by some chemistry teachers, abstract nature of some concepts/topics as well as lack of interest among chemistry students (Eriba, 2012, Njoku, 2009, Jegede, 2007).

The students' inability to comprehend and remember what has been learnt is mostly caused by a teacher-centred approach that makes learners passive listeners. Research findings have shown that certain topics such as chemical formulae and equations, energy in chemical reactions, structure of Organic Compounds, the Mole Concept, Electrolysis and Ions in solution are among the most difficult to students due to their abstract nature (Olatoye, Aderogba and Aanu, 2011). This result in decreasing students' motivation, thus lower their academic achievement in chemistry. According to Yusuf (2014), the most important factor that generally influences achievement in science is the teacher and the teaching methods adopted. This is because teachers can use their skills to manipulate all other factors and gear them towards improving students' motivation, participation and achievement in science. However, findings have shown that most chemistry teachers are at a loss on how to effectively utilize some teaching methods identified to be effective through research in science education (Demide, 2011; Fatokun, 2012; Olatoye, Aderogba & Aanu, 2011; Ugwu, 2014). The persistent use of the traditional teaching methods employed by some chemistry teachers during teaching have not been promoting effective learning. From research evidences, researchers see the challenging need to reconsider the techniques and methods of instruction.

Learning is a personal activity and each student has to construct his/her own knowledge (Taber, 2009). For learning to be personalized, it demands that learners should show commitment and interest as well as active participation in the learning process for meaningful understanding and assimilation of information (Audu and Achor, 2003). In view of this, science teaching ought to be proactive and student-centered for meaningful learning to take place. However, Njoku (2009) observes that science teaching in Nigeria is still done expositorily even when the method used by the teacher neither promotes students' motivation nor academic achievement partly because of the teachers' inadequacies and reluctance to adopt innovative teaching strategy such as inquiry strategy which had been proved effective in enhancing learning outcomes.

Teaching science by inquiry involves teaching students science process skills, critical thinking, scientific reasoning skills used by scientists (Barrow, 2006). Inquiry is defined as the acts scientists use in doing science and it can be a highly effective teaching method that helps students to understand concepts and use of process skills (Yagger & Akcay, 2010). Inquiry strategy is a style or method of teaching where the learner seek to discover and create answers to a recognized problem through a procedure of making systematic searching, sometime with minimum guidance from the teacher (Maxwell, Lambeth & Cox, 2015). Inquiry as a process, focused on framing problems, critical experimentation, planning, assessment of alternatives, gathering information, exploration and verification, designing models of the studied process, discussion with others and forming rational arguments (Thoron & Myers, 2011). Inquiry strategy is also a term used in science teaching that refers to a way of questioning, seeking knowledge, information or finding out about phenomena that involves investigation and arriving at a conclusion (Sola and Ojo, 2007). In inquiry strategy, students learn not only concept but also self-direction, responsibility and social

communication. It also permits students to assimilate and accommodate information. It is the way people learn when they are left alone.

According to Cheval and Hart (2005), Inquiry strategy was classified into three (3) namely: Structured Inquiry, Open Inquiry and Guided Inquiry. Structured Inquiry is teacher-centred commonly seen in science classrooms in form of laboratory exercises where teacher provides structured procedures and students carry out the investigations. It is regarded as the most traditional approach to inquiry (Cheval and Hart, 2005). The Open Inquiry requires the least intervention of a teacher and is student-centered where students often work in groups and plan all phases of their investigations while Guided Inquiry falls in the middle of the inquiry instructional spectrum. This type of inquiry is commonly used when students are asked to make tools or develop a process that results in a desired outcome (Kazempour, 2009). Guided inquiry strategy will be used in this study due to its scientific nature as it involves all scientific process which enhance the academic achievement of students since it is student-centered where students will be given a problem and materials to develop method and find answers to the identified problem that also improve their motivation because students learn better when they are allowed to discover facts by themselves.

Motivation can be used to determine the behavior of an individual. It affects ones' learning, achievement, attention, thinking, interest, perception, feelings, creativity and remembering. Motivation can be defined as any inner condition or feeling of an individual that initiates, energizes and direct his behaviors toward achieving a predetermined goal (Cirick, 2015). Motivation is one of the conditions that drives and sustains learning behaviors. Guided inquiry can also enhance the motivation of students as it gives room for students to develop procedure and problem to be solved through active involvement and manipulation of objects during the process of guided inquiry.

There are many motivational constructs that could relate to academic success in science particularly Chemistry. However, this present study will focuses on intrinsic and extrinsic motivation as predicator of success in chemistry. Intrinsic motivation refers to internal desires to perform a particular task which is rewarded by completing the task while extrinsic motivation refers to performance of a task in order to receive an external reward (Ryan and Deci, 2000). In academic situations, intrinsic motivation leads to deeper processing, greater mastery and better implementation of learning strategies (Covigton, 2000). Intrinsically motivated students are also more likely to persist with challenging tasks and other positive classroom behaviors as well as perform significantly better than extrinsically motivated students who might have been bribed before performing a given task (Tella, 2007; Wang, 2011). Motivation to learn science at junior secondary school level is one of the most important predicators of success in science course (Britner and Pajares, 2006). Student who had high intrinsic and high extrinsic motivation outperformed significantly than those who had low intrinsic and low extrinsic motivation.

A vital issue in science teaching nowadays is mainly on selecting effective method of teaching that can go along with different categories of learners. Most of the authors cited in this study are of the opinion that selecting effective teaching method which can improve students' academic achievement and motivation is very important in science teaching. However the researcher decided to investigate the effect of guided inquiry strategy on the academic achievement and motivation of students in Organic Chemistry.

1.2 Statement of the Problem

Despite the recommendations of studies conducted on inquiry instructional strategy as a tool for improving students' academic achievement and motivation and wider applications of Chemistry in our daily life activities as cited by Abdi (2014), Lucy (2015), Tuan, Chin, Tsai and

Cheng (2005), students' performance have shown to be poor over years based on WAEC (2013-2015) record analysis.

In the year 2012, only (18%) of the registered candidates passed the examination at credit level. In the same way, 2560 candidates sat for the WAEC 2013 Chemistry examination, where only 528 (21%) candidates passed at credit level and majority of the students failed. Likewise in 2014 academic year, Only 708 (27%) candidates passed the examination at credit level among the total of 2643 registered candidates. Also in 2015 academic year, 2707 candidates sat for the WAEC Chemistry examination, less than (30%) of the students passed at credit level and more than (70%) failed. Also in 2016 academic year, 2815 candidates sat for the WAEC Chemistry examination, only (32%) of the students passed at credit level and more than (60%) candidates failed. There were 3006 registered candidates in 2017 academic year, a total of 920 passed at credit level and the rest of the students could not make it.

Studies on the causes of students' failure in Chemistry revealed that poor instructional method used by some Chemistry teachers (Adams, 2016), lack of motivation (Palmer, 2007), lack of practical facilities (Korau and Saage, 2009) and abstract nature of Chemistry (Olatoye, Aderogba, and Aanu, 2011) are among the factors responsible for lowering the academic achievement of students in Chemistry. This study intend to use guided inquiry strategy in order to ascertain its effect on students' academic achievement and motivation as well as the effect of the strategy with respect to gender.

Table 1.1 shows the performance of Chemistry students in WAEC examination in Katsina state from (2012-2017) academic year.

Table 1.1: Performance of Students in WAEC Chemistry Examination (2012-2017) in Katsina State

Year	No.of Students Registered	No.of Students Passed	No.of Students Failed	% Passed	% Failed
2012	2210	401	1809	18	82
2013	2560	528	2032	21	79
2014	2643	708	1935	27	73
2015	2707	654	2053	24	76
2016	2815	911	1904	32	68
2017	3006	920	2086	31	69

Source: Katsina State Ministry of Education, (2017)

1.3 Objectives of the Study

The main purpose of this research is to investigate the effect of guided inquiry strategy on the academic achievement and motivation of students in Organic Chemistry. The objectives of the study are to:

1. Determine the academic achievement of students in Organic Chemistry when taught using guided inquiry strategy.
2. Determine the academic achievement of male and female students in Organic Chemistry when taught using guided inquiry strategy.
3. Find out the motivation level of students in Organic Chemistry when taught using guided inquiry strategy.
4. Investigate the motivation level of male and female students in Organic Chemistry when taught using guided inquiry strategy.

1.4 Research Questions

Based on the stated objectives, the following research questions were asked:

1. What are the mean achievement scores of students taught Organic Chemistry using guided inquiry strategy and those taught using lecture method?
2. Is there any difference in academic achievement between male and female students when taught Organic Chemistry using guided inquiry strategy?
3. What is the Motivation level of students taught Organic Chemistry using guided inquiry strategy?
4. Is there any difference in Motivation level between male and female students when taught Organic Chemistry using guided inquiry strategy?

1.5 Research Hypothesis

Based on the stated research questions, the following null hypotheses were used to guide the study.

$H_0$1: There is no significant difference in the academic achievement of students taught Organic Chemistry using guided inquiry strategy and those taught using lecture method.

$H_0$2: There is no significant difference in the academic achievement of male and female students taught Organic Chemistry using guided inquiry strategy.

$H_0$3: There is no significant difference in the motivation level of students taught Organic Chemistry using guided inquiry strategy.

$H_0$4: There is no significant difference in the motivation level of male and female students taught Organic Chemistry using guided inquiry strategy.

1.6 Significance of the Study

The findings of this study would be beneficial to the Ministry of Education, Curriculum planners, Professional bodies, Researchers, Book publishers, teachers and students.

The findings of this research work can be used by the Ministry of Education in organising an in-service training for science teachers as well as workshops, seminars and conferences for chemistry teachers on the use of guided inquiry strategy in order to improve in their teaching and learning. The result of this study will assist Chemistry curriculum planners like Nigerian Educational Research and Development Council (NERDC) who are responsible in designing, developing and reviewing Chemistry curriculum in Nigeria to ensure the attainment of the set goals and objectives of SS II Chemistry curriculum by incorporating guided inquiry in the curriculum.

Similarly, professional body like Science Teachers' Association of Nigeria (STAN) will also benefit from the result of this research work by sensitizing and re-training of science teachers about guided inquiry strategy as a method of teaching Chemistry through workshops, conferences and seminars which the STAN use to organize to its members annually.

Researchers particularly in the field of science education and other science related disciplines will benefit from the outcome of this study. The research findings will serve as a source of literature review as well as a guide for subsequent researches. The research findings will also be identifying areas for further studies in teaching strategies other than guided inquiry with a view to furnish teachers about modern ways and procedures of conveying information to students during teaching and learning which in turn enhances academic achievement and motivation of secondary school students. Textbook publishers may also appreciate the findings of this study by reflecting suitable approaches to the use of guided inquiry in conveying knowledge and information while designing Chemistry textbooks.

Teachers and students will also benefit from the outcome of this study by appreciating the effectiveness and practicality of guided inquiry strategy by employing the strategy in teaching Chemistry concepts in order to enhance and improve the academic achievement and motivation of students via manipulation of materials as well as active involvement of students during learning process.

1.7 Scope of the Study

The aim of this study is to determine the Effects of Guided Inquiry on Motivation and Academic Achievement in Organic Chemistry among Secondary School Students in Musawa, Katsina State, Nigeria. All co-educational public Senior Secondary Schools in the zone were used as the population of the study. The study used SS II Chemistry students and the topic taught was Hydrocarbons which was selected from Senior Secondary School Two (SSII) syllabus. The topic was perceived among the difficult topics in Organic Chemistry according to WEAC (2013-2015) Chief Examiners' Report.

CHAPTER TWO

REVIEW OF RELATED LETERATURE

2.1 Introduction

This chapter presents the previous studies that have provided theoretical and empirical background relevant to the present study. The chapter discusses the literature review under the following headings:

- Theoretical Framework
    - John Dewey Theory of Constructivism
    - Bruner's Cognitive Theory
    - Theory of Motivation
    - Gender Schema Theory
- Conceptual Framework
    - Concept of Chemistry
    - Concept of Organic Chemistry
    - Concept of Motivation
    - Concept of Gender
- Academic Achievement of Chemistry Students
- Instructional Strategies in Teaching Chemistry
- Traditional Method of Teaching
- Inquiry Method of Teaching
- Academic Achievement and Motivation
- Gender Issues in Teaching and Learning of Chemistry

- Review of Related Empirical Studies
- Implications of Literature Reviewed for the Present Study

2.2 Theoretical Framework

According to Alkali (2009), a theory is an idea, fact or principle that can be used to describe a given concept. This study is based on the theories of cognitive science particularly John Dewey theory of constructivism and Jerome Bruner's cognitive theory.

2.2.1 John Dewey Theory of Constructivism

John Dewey (1938) was a philosopher, psychologist and educational reformer who immensely contributed and influenced education especially in areas like inquiry teaching and learning. Dewey states that 'knowledge emerges only from situations in which learners have to draw them out of meaningful learning. Constructivism is a theory used to explain how people know what they know. The basic idea is that problem solving is at the heart of learning, thinking and development. According to Young and Collins (2003), constructivism theory provides a framework through which the emergent ideas about teaching, learning and assessment can be unified. According to this theory, the difficulty and challenges confronting teachers is that the reform strategies in curriculum, instruction and assessment organized around the theory of "constructivism" are informed by different assumptions and about the nature of knowledge and the human capacity to learn than are traditional practice (Kim, 2005). Constructivism as a psychological theory argues that human construct knowledge and meaning from their experiences. The theory lays emphasis on not accepting what you are told but the prior knowledge about what you are taught and the perceptions about it. Active involvement of students is emphasized in

constructivism, hence knowledge gained last long in students' memory. Kant (2008) further highlighted this idea by asserting that human beings are not passive recipients of information.

Parim (2009), stated inquiry strategy as a way of asking questions, seeking information and finding new ideas related to an event. That is, in inquiry strategy, students learn by using cause and effect, relational and critical thinking and combining both scientific knowledge and procedures. Students come into a classroom with their own experiences and a cognitive structure based on those experiences (Mahoney, 2004). The memorized information that has not been connected with the learners' prior experiences will be quickly forgotten. In short, the learner must actively construct new information onto his/her existing mental framework for meaningful learning to occur. Based on this fact, it is regarded that inquiry strategy which is an activity based learning method will aid better learning outcome in chemistry. During inquiry strategy, students are actively involved in the learning process facilitated by the teacher. In a constructivist, the role of the teacher is to organize information around conceptual masses of problems and questions in order to engage the student.

Teachers assist students in developing new insights and connecting them with their previous learning as Sincero (2006), Zion and Mendelovici (2012) described inquiry strategy as student-centered learning derived from student questioning, interest, curiosity and background knowledge which allow the student to dive intensely into the material. Cognitive theories look beyond behavior to explain brain-based learning. Students are encouraged to ask questions, conduct experiments, make their own comparisons and come up with their own conclusions (Vonglaserfeld, 1989). Cognitivists consider how human memory works to promote learning. For example, the psychological processes of sorting and encoding information and events into short term memory and long term memory are important to educators working under the cognitive

theory. Cognitive theorists believe that the role of a teacher is to provide learners with opportunities and motivations to learn. Learners actively take knowledge, connect it with previously assimilated information and make it theirs by constructing their own understanding (Cheek, 1992).

The constructivist theory supports cognitive pedagogy where individuals have innate sense of the world which allows them to shift from passive listeners to active learners (Parim, 2009). Alternative to change the focus of learning situation from teacher dominated to active involvement of student is highly emphasized in constructivist theory of learning, hence knowledge last longer in their memory. Using guided inquiry, constructivism is not accepting what you are told but a preceding knowledge of what you were taught and your perception about it. Dewey (1938) argued that education and learning are social and interactive processes and that the school as a social institution provides an environment in which social developments would take place. Dewey also believed that students prosper in an environment where they are allowed to experience and interact with the curriculum and as such he emphasized that all students should have the opportunity to take part in their own learning.

As a constructivist, Dewey (1938) also believed that teachers are partners in the learning process whose guidance and assistance help the learners to independently construct knowledge and meaning within the subject area. Dewey is of the view that the primary responsibility of educators is to assist shaping the knowledge by providing suitable condition for students to utilize their environment to build up experiences that will interact with students' personal desires for effective learning to occur (Exline, 2004). Dewey also highlighted the importance and relationship between student and curriculum, hence emphasized that curriculum should be presented in a way that allows students to relate the information to prior experience thus deepening the connection with their new knowledge.

Effective inquiry is more than asking questions but involves a complex process of converting information into useful knowledge (Martin-Hansen, 2007). The essence of inquiry process is to ask questions that stimulate students to think critically and formulate questions thereby constructing knowledge using scientific processes like observing, inferring, predicting, classifying, measuring, hypothesizing, experimenting and interpreting data (Campbell, 2006).

The implication of Dewey's theory is that students must be engaged in meaningful activities that make them to apply the concept they are trying to learn, where the teacher's role is to provide an enabling environment via guided inquiry strategy for effective learning to take place.

2.2.2 Bruner's Cognitive Theory

Bruner was a cognitive theory developmental Psychologist who conducted an in-depth study in areas like human perceptions, motivation, learning and thinking (Nnachi, 2007). Bruner viewed human beings as information processor, thinker and inventor of ideas whose cognitive developments occurs through the interaction and exploitation of the environment. Bruner believed that learning is effective when learners are given the opportunity to discover facts by themselves. Bruner therefore sees the acquisition of knowledge as an active process and so encouraged learners' independence and personal involvement in the learning process. To him, learners' independence fostered through encouraging students to discover new principles on their own consensus lies at the heart of effective education. Bruner encouraged for a spiral curriculum which can enable students to build upon what they have already learnt in the order of these principles:

- Instruction must correspond to the experiences that make students have ability and willing to learn (readiness)
- Instruction must be structured so that it can be easily understood by the student (spiral organization).

- Instruction should be designed to facilitate extrapolation (going beyond the information given).

The implication of Bruner‘s theory to inquiry strategy is that teachers should create situations that would help learners to discover facts by themselves.

2.2.3 Theory of Motivation

Self-Determination Theory (SDT) has been developed to try to integrate both the intrinsic and extrinsic factors in human motivation thus incorporating both the intra-psychological and socio-cultural aspects of other research frameworks (Pintrich 2003; Ryan and Deci, 2000). Self Determination Theory encompasses five mini-theories: Cognitive Evaluation Theory (CET), Organismic Integration Theory (OIT), Causality Orientation Theory (COT), Basic Psychological Needs Theory (BPNT) and Goal Content Theory (GCT). The conceptual framework on which Self Determination Theory is based identifies three basic needs on which psychological health and well-being depend: competence, relatedness and autonomy (Ryan and Deci, 2000).

A brief summary of these sub-theories as described by Hagger & Nikos (2011):

- Cognitive Evaluation Theory (CET) addresses the topic of the influence of social contexts on intrinsic motivation. Competence and autonomy are considered crucial aspects of intrinsic motivation in this theory.
- Organismic Integration Theory (OIT) primarily considers extrinsic motivation and proposes a band of internalization through which an individual may develop autonomy with regard to extrinsic conditions.

- Goal Content Theory (GCT) also addresses intrinsic and extrinsic motivation. The theory contrasts goals with intrinsic value such as those related to community and personal growth with goals that are extrinsically oriented such as those related to wealth and fame. The theory argues that goals that support the three basic needs of autonomy, relatedness and competency will support psychological well-being while extrinsically oriented goals will negatively impact well-being.
- Causality Orientation Theory (COT) is concerned with individual orientation toward environment, identifying three primary types, namely; the autonomy orientation, the control orientation, and the amotivated orientation.
- Basic Psychological Needs Theory (BPNT) proposes the three basic needs outlined above (autonomy, competence and relatedness) and argues that environment that support these needs promote psychological wellbeing.

Although the sub-theories address different aspects of Self-Determination Theory (SDT), they all rest on the foundational tenet that support the basic needs for autonomy, competency and relatedness which results in positive motivation and healthy personal development. Studies have shown that the more externally regulated are motivations, the less interest and effort students display and the more students are likely to blame others for negative outcomes (Bernard, 2005). So, greater internalization of extrinsic motivation should lead to benefits in terms of active engagement and persistence by learners and if this is accurate, then creating learning environments that foster internalization of extrinsic factors may be one way to support positive academic outcomes.

2.2.4 Gender Schema Theory

Gender schema theory was formally introduced by Sandra Bem in 1981 as a cognitive theory to explain how individuals become gendered in society and how sex-linked characteristics are maintained and transmitted to other members of a community (Hoffman & Borders, 2001). Gender-associated information is predominantly transformed through society by way of schemata or networks of information that allow for some information to be more easily assimilated than others. Bem (1981) argues that there are individual differences in the degree to which people hold these gender schemata. These differences are manifested by a degree to which individuals are sex-typed.

Being that gender schema theory is a theory of process and not content, this theory can help to explain some of the process by which gender categorizes become so psychologically deep rooted in our society. Specifically, having strong gender schemata provides a filter through which we process incoming stimuli in the environment that leads to an easier ability to assimilate information that is fix similar, hence further solidifying the existence of gender stereotypes. Within teenage development, Bem (2001) hypothesizes that student must choose among surplus of dimensions, but that gender schemas lead to the regulation of behaviors that imitate the cultural definition of what it means to be male or female. Additionally, it was asserted that there is also a heterosexuality subschema, which likely encouraged the development of gender schemas. Most societies treat exclusive heterosexuality as the benchmark for proper masculinity and femininity. Furthermore, the heterosexuality subschema asserts that men and women supposed to be different from one another. It is hypothesized that this is why cross-sexed interactions are likely to be sexually coded.

2.3 Conceptual Framework

2.3.1 The Concept of Chemistry

The objectives of senior secondary school chemistry curriculum include among others that students should be taught to acquire theoretical and practical skills and develop interest in the subject (Federal Government of Nigeria, 2012). Therefore, Science Teachers are expected to device ways of motivating their students to develop positive attitudes towards science and science related disciplines (Sola and Ojo, 2007). One of the major goals of education is to make students gain the thinking skills and strategies which they will use throughout their lives rather than storing information. A good education should be able to equip students on how to learn, how to remember, how to motivate themselves and how to control their own learning. Chemistry is one of the three main branches of pure science, the others being Biology and Physics. Chemistry is the study of the properties of substances and as everything you see is a substance of some kind or another. Chemistry teaching according to Usman (2000) supposed to be result oriented and this can only be achieved when students are willing and teachers are using appropriate method and research in teaching. That is, students need to actively construct their own personal awareness and meanings.

Students study chemistry in order to acquire and learn scientific process of observation, recording and making intelligent conclusion from observation. Studying chemistry give students training in scientific methods and the knowledge of chemistry help students to become scientists. Chemistry as described by Ibrahim (2006) helps in improving the quality of our life today. All the household materials we use in our daily lives such as cooking utensils, plastic materials, perfumes, hair creams, detergent and soap among others are all produced through chemical processes (Wong, 2002). Moreover, chemistry contribute immensely in providing our basic needs and in improving

the quality of human life in many areas like health, security, transportation, agriculture and industries.

According to Wong (2002), Chemistry contributes towards providing our basic needs and improving the quality of our life in the following areas:

1. Agriculture: production of different types of fertilizers and insecticides have been made possible by chemical means which greatly increase food production. The preservation and storage of food for long period of time is made possible as a result of chemicals prepared by chemists through chemical process so that the food can be kept for a long time without being changed and exported to distant places.
2. Man-made textile fibers products are as a result of intensive chemical researches and experiments that has made available a wide range of clothing materials which supplements the scarce natural fibers. Building materials such as cement, steel, bricks and tiles are produced by chemical industries. These properties can be modified through chemical reactions to suite certain purposes.
3. The healthy life many of us are enjoying today is due to the variety of medicines that are available as a result of advanced chemical researches in chemistry laboratories.
4. Career in chemistry: Nigeria is a developing nation with an increasing demand for skilled man power. Many job opportunities are available for students with knowledge of chemistry in the public and private sectors. These opportunities are more fundamental in areas like Teaching services, chemistry teachers in secondary schools and lecturers in polytechnics, colleges of education and universities, laboratory assistants in schools and universities, nurses and medical assistants are all students of

chemistry. That is to say, they must have learned chemistry before being what they are (Garba, 2006).

2.3.2 The Concept of Organic Chemistry

The term Organic is used to describe Carbon containing compounds. All other compounds from mineral origin are called Inorganic. These terms are used to describe two branches of Chemistry, namely Organic Chemistry and Inorganic Chemistry.

Organic Chemistry according to Baxter, Ibezim & McDuell, (2014) is the study of compounds of Carbon (except trioxocarbonates (IV) and oxides of Carbon). Organic compounds contain elements such as Carbon, Hydrogen, Oxygen, Nitrogen, Sulphur, Phosphorous and the Halogens. Some Organic compounds such as carbohydrates and proteins are important for life. The compounds of Carbon furnish one of the most fascinating aspects of our study of Chemistry. One reason why their study interests us is that they play a dominant role in the Chemistry of living things, both plant and animal and also there are innumerable Carbon compounds that have been found useful to man, for example drugs, fibres, plastics, detergents, soaps, perfumes, textiles and fertilizers to name only a few. Compounds of Carbon are numerous on the earth's crust typically inform of Coal (85-95% of Carbon), certain plants and animals synthesize many useful Carbon compounds such as sugars, starches, dyes, drugs and fibres. Petroleum is a complex mixture of compounds of very wider range of volatility and natural gas which is a mixture of low relative molecular mass compounds called Hydrocarbons (compounds containing Carbon and Hydrogen only).

2.3.3 The Concept of Motivation

Motivation is one of the most frequently used term in psychology. Motivation can be defined as the process of activating, maintaining and directing behavior towards a specific goal. Motivation is the process of initiating action. Motivation refers to the factor responsible for activation of an individual. Motivation is not usually directly observable, it is inferred and use to explain certain behavior (Cirick, 2015). We infer the presence of motivation when we see that peoples work toward attaining certain aims and objectives. For instance, we might observe that an individual works hard at almost every task that comes to him; from this we infer that the person has motive to achieve. All human behaviors seem to arise in response to some form of external and internal stimulation. The behaviors are not at random but however they are purposive or goal oriented that take place by arousing of certain motives. Motivation is probably the most important factor that educators can target in order to improve learning process (Wang, 2008).

A number of theories have been postulated to explain motivation each having some truth, but none of the theories satisfactorily describe all human motivation because human beings are complex creatures with complex needs and desires. Students' learning is regarded very minute unless they are motivated on a regular basis. Some theories claim that students are motivated by material rewards, desire to improve their power and prestige in the world, interest work, enriched environments, recognition or being respected as an individual. Students are not purely physical, economic, political or psychological beings as Beecher (2000) said 'God made man to go by motives and he will not go without them any more than a boat without steam or a balloon without gas. Students' motivation is an essential element that is necessary for qualitative education. Students pay attention, begin working on tasks immediately, ask questions and volunteer answers and appear to be happy and eager when they are motivated (Palmer, 2007). The students must have

ability, access, interest and value to education. The teacher must be well trained, dedicated, inspirational and responsive to his students and must monitor educational process. The concept must be accurate, timely, stimulating and relevant to students' present and future needs. The method must be inventive, interesting, encouraging and beneficial and also provide tools that can be applied to students' real life. The environment ought to be safe, accessible, positive, favourable, personalized and empowering. According to D'Souza and Maheshwari (2010), Motivation is optimize when students are exposed to a large number of these motivating variables and experiences on a regular basis. That is to say, students should have many sources of motivation in their learning experience in every class. The students' role in education is crucial and should go beyond the traditional view of student as a recipient of knowledge. In addition, students are the raw-materials for education and the primary products of educational transformation by means of effective inquiry teaching.

Intrinsic and extrinsic motivation separately predicted students' achievement as stated by Vatankhaha and Tanbakooeib (2014). They further added that significant positive relationship between intrinsic motivation and students' achievement was found and there was a negative relationship between extrinsic motivation and students' achievement. Glynn, Taasoobshirazi and Brickman (2009) investigated the relationship between overall motivation to learn science and achievement in science and they reported that students found science courses relevant to their careers and their motivation and achievement were higher.

2.3.4 The Concept of Gender

Gender is a cultural construct that distinguish roles, behavior, mental and emotional characteristics between males and females developed by a society. Gender refers to the roles and responsibilities of men and women that are created in our society and our culture. Gender relates

to the cultural attributes of both males and females (Akpochato, 2009). The concept of gender also includes the expectations held about the characteristics, abilities and likely behaviors of both men and women in a given society. Umoh (2003) defines gender as a psychological term used in describing behaviours and attributes expected of individuals on the basis of being either male or female. Gender equally projects the properties that distinguish and classify organisms on the basis of their reproductive and cultural expectant roles. It relates to the cultural and psychological attributes of men and women through their socio-economic contributions, expectations and limitations as opined by Singh (2010) that gender refers to a socio-cultural concept that connotes the differentiated roles and responsibilities of men and women in a particular society.

According to Okeke (2003), the study of gender is not just mere identification of male and female sexes. Scholars have gone further to identify responsibilities assigned to opposite sexes and to analyze the conditions under which these responsibilities are assigned. Okeke (2003) specifically noted that the study of gender means the analysis of the relationship of men and women including the division of labour, decision making, knowledge, access to resources and other factors which are determined by society as opposed to being determine by sex. Gender is not based on sex or the biological difference between men and women rather gender is shaped by cultural, social relations and natural environments. Depending on the norms and values, customs and laws, men and women in different part of the world have evolved different gender roles and responsibilities, thus the concept of gender does not suggest the dominance of male over female or vice versa in academic setting and other human development areas but it stresses the equity and equality in enhancing effective recognition and utilization of abilities and competencies of both sexes.

2.4 Academic Achievement of Students in Chemistry

Achievement is a learners' scholastic upright at a specific time which has to do with the successful attainment of educational objectives (Adeyemi, 2008). The reason for measuring the achievement is to help the teacher and the learners to evaluate and estimate the level of success attained in a given learning situation, usually obtained from continuous assessment (test or assignment) which is also important in determining the effectiveness of instructional method.

Despite the contribution and importance of chemistry to the nation, studies indicated that students' academic achievement in chemistry at senior secondary school certificate examination (SSCE) has been very low that is linked to some factors among which are instructional methods and learning environment (Fatokun, Egya and Uzoechi, 2016). Likewise Omiko (2015) and Dahiru (2013) reported that secondary school students' achievement was very low in WAEC examinations.

The data obtained from Katsina State Ministry of Education revealed that a total of 3006 candidates sat for WAEC examination in 2017 academic year, but only 31% were able to passed at credit level. Eventually there was an increase in failure from 68%, 76% to 79 in 2016, 2015 and 2013 academic year respectively. This indicated that chemistry students' performance is very low and not inspiring in Katsina state. This necessitated the need to overcome the unwilling situation of low academic achievement of Chemistry students, thus the need to undertake this research work. The low academic achievement of students in Chemistry has been linked to some factors like availability and quality of science teachers, lack of using appropriate teaching methods, inadequate laboratory equipments, lack of proper arrangement for the lesson, students' interest, students-teacher relationship (Korau and Saage, 2009). According to WAEC chief examiners' reports (2013-2015) showed that academic achievement of students in Chemistry is declining.

2.5 Instructional Strategy in Teaching Chemistry

Teaching is the act, practice, occupation or profession of a teacher. Teaching is an academic process where students are motivated to learn in a way that make a positive influence on how they think, act and feel. Teaching strategies in science education refers to the methods used by science teacher to involve students with subject matter in order to achieve the stated goals (Mandore, 2002). Education is concerned with the process of transferring knowledge, skills, values, attitudes needed by an individual to live effectively in his environment. The process used to achieve this is known as teaching method or instructional strategy. In science education, teachers should be knowledgeable in the various methods and strategies for teaching science subjects. The strategy employed by a teacher whether directly or indirectly influence learning. Researches from Audu and Achor (2003), Olatoye (2009), Adams (2016) revealed that instructional strategy is the main factor that hinders better academic achievement in Chemistry. To ensure better academic achievement of students in Chemistry, researchers have suggested the use of effective instructional strategies such as inquiry strategy that will motivate students through active participation of students during learning.

2.6 Traditional Method of Teaching

Traditional method is an oral lecture method or way of teaching as stated by Bimbola (2010). Traditional method implies a one way approach of conveying knowledge, skills, norms and values where the teacher is active and learners are passive listeners. According to Donald (2000), stated that lecture method is the most frequently used method in teaching. However, Chemistry teaching is dominated by traditional approach as confirmed by Bichi (2002) that traditional method is usually used by science teachers in Nigeria. Traditional method is an old approach to teaching where knowledge is commonly presented to the learners. The method is

characterized by accommodating a large number of audiences typically employed in high secondary school and tertiary institutions of learning. It is a fully teacher-centered approach where the teacher always dominate the class while presenting information (Colburn, 2000).

Advantages of Lecture Method as outlined by Kaur (2011)

1. Lecture method is one of the most efficient teaching methods for presenting many facts or information in a relatively short time. Material that has been logically organized can be presented concisely in a rapid sequence.
2. Lecture method is particularly suitable for introducing a subject. To ensure that all students have the necessary background to learn a subject, basic information can be presented through lecture method. By using lecture method, one can offer students with varied backgrounds, a common idea and understanding.
3. Lecture method is a convenient method for instructing large groups. If necessary, one can use a public address system to ensure that all students can hear. The lecture method is sometimes the only effective method to use if student-to-teacher proportion is high.
4. Lecture method is often useful to supplement material from other sources or for information difficult to obtain in other ways. If students do not have time for research or access to reference material, the lecture method can fill the gap. In subject areas where information is available in widely scattered places, the lecture allows the instructor to summarize and emphasize on relevant information. Reports, current research and information that change frequently may not be easily available in written form and the lecture can give students the most up-to-date information.

5. Lecture method allows a large number of students to receive information from real experts in a subject. In general, a person who can speak from actual experience or a scholar who has carefully analyzed the results of a research will have great credibility with students.
6. Lecture method is often the most effective way of communicating the energy and eagerness of a person who has actual experience in a field.

Disadvantages of lecture method as provided by Kaur (2011)

1. Lecture method does not lead to maximum achievement in certain types of learning. Speech skills, cooperative group thinking and motor skills for example are difficult to teach with lecture method. Students can develop such skills well only through practice.
2. The formal lecture alone is generally not appropriate for presenting material above the comprehension level of the learners' cognitive domain because it allows for little or no student verbal participation. The formal lecture method may also be ineffective for comprehension level lessons in which concepts and principles are developed.
3. Lecture method does not provide teachers with an opportunity to estimate students' progress before an examination. Within a single lecture period, one may unknowingly present more information than the students can absorb and have little accurate means during the lecture in determining what they have learned.
4. Lecture method makes no provision for participation by the students. As a result, many students willingly allow the instructor to do all the work. Learning is an active process but the lecture method tends to foster passiveness and dependence on the instructor.
5. Instructors may have to spend much time preparing for the lectures. With demonstration method of instruction, students participate actively and with the case study and guided discussion methods, students participate verbally. Teaching interview relies heavily on the

knowledge of an expert and provides for student involvement through a question and answer period but with lecture, a greater burden for the total lesson rests on the instructor.

6. Finally, many instructors find it difficult to hold the attention of their students when they give lecture for an entire class period. To use lecture method effectively, we obviously need considerable skill in speaking.

2.7 Inquiry Method of Teaching

Science has been taught by a method where the instructor give information to students who are given a textbook or assignment to complete (Furtado, 2010). This method of teaching science might have been effective for test scores but proved ineffective for increasing literacy in science. The study of science through real-life problem-solving skills and understanding of the universe needs to be increased as well as their test scores at the end of academic instruction. According to Varma, Volkmann and Hanuscin (2009) stated that science should be taught and learned through inquiry. Memorizing facts will not improve skills in science students but the freedom to investigate and explore by themselves through inquiry will greatly enhance their cognitive ability. Therefore science teachers should move away from traditional approach and cookbook style to active learning strategies such as inquiry strategy, problem-based learning and cooperative learning which help students in developing their cognitive abilities thereby becoming lifelong learners (Tessier and Penniman, 2006).

Teaching through inquiry strategy can improve students' academic achievement and motivation by providing an open learning situation that give students ability to explore and make meaningful learning (Wolf and Francer, 2008). Inquiry teaching emphasizes the development of inquiry skills and nurturing of inquiry habits of mind that will enable individual to continue the quest for knowledge throughout life as maintained by Hanson (2005) that learning becomes more

effective and permanent when learners propose questions, examine and discuss their findings and finally construct their knowledge understanding.

Inquiry strategy to learning have a long and strong tradition especially in science education. It is one of the instructional approaches that situate learning in a meaningful task. Inquiry strategy is a pedagogy that best enables students to experience the process of knowledge creation and the key attribute is that learning stimulated by inquiry which is a student-centered and an active approach to learning. One approach to promoting meaningful learning is by students' active participation through inquiry strategy. New knowledge is gained as students collect data, analyze data and solve problems by themselves.

Inquiry strategy is well suited to helping students become active learners because it situates learning in real-world problems and makes students responsible for their learning as it has the dual emphasis of helping learners develop strategies and construct knowledge thereby allowing students to interact with materials, models, manipulate variables, explore phenomena and attempt to apply principles that afford them with opportunities to notice patterns, discover underlying causalities and learn in ways that are seemingly more robust (Alfieri, Brooks, Aldrich and Tenenbaum; 2011). When students are allowed to investigate, reason and organize knowledge, they are able to incorporate new knowledge into their understanding of the world around through gathering knowledge (Miller, McNeal and Herbert, 2010).

According to Rattanavongsa and Rachahoon (2014) stated that inquiry strategy supports students application of knowledge, understanding the real world situations and supports discovery. Furtado (2010) & Varma, et al (2009) suggested that for students' achievement, engagement and higher order thinking skills to be improved, they must be instructed through inductive process such as inquiry strategy. According to Wall, Dillon and Knowles (2015), inquiry strategy helps

educators to improve students' confidence and learning. In order to implement inquiry strategy effectively, science teachers must become comfortable with employing basic instructional strategies during learning situations and acquire the basic knowledge of the subject matter. Studies as suggested by Irinoye, Bamidele, Adetunji and Awodele (2014) develop full conception of scientific facts and principles by involving in student-centered practices in guided inquiry strategy. Students are more active and they guide their own learning processes during inquiry strategy. The three categories of inquiry as outlined by Cheval & Hart (2005) are structured, guided and open inquiry. In structured inquiry, the teacher constructs the problem and the process while in guided inquiry the teacher asks the questions and students construct solution process, determine the problems in a given context and try to solve them in an open inquiry approach. Continued research in the area of science instruction would have essential implications that will aid in drawing conclusions about the efficacy of inquiry strategy.

Inquiry strategy is therefore recommended for teaching Chemistry because it provides students with the opportunity to explore the world of things around them through the scientific process. Many researchers like Ibe (2004) Chukwuemeka (2005) Nwagbo (2006) and Opara (2011) recommend the use of inquiry method for Chemistry teaching because it promotes process skill development which is needed for scientific investigations. Similarly, Orlich, Hader, Callahan, & Gibson (1998) identified inquiry as a better method of teaching Chemistry because it encourages active interaction between students, teachers, materials and environment and allows both the students and the teacher to become persistent questioners, seekers, interrogators and ponders and also combine all learning processes that encourage knowledge discovery and construction. It begins with gathering information and data through the application and use of human senses by

formulating questions that arouse the thinking ability towards knowledge construction and problem solving.

In support of the above view, Onan (2012) outlined the following inquiry process:

- Identification and selection of problem and conducting research
- Introducing process and problem presentation
- Gathering data
- Developing theory and verifying the theory
- Analyzing the process and
- Evaluation

In science teaching, there is no authentic investigation or meaningful learning if there is no inquiry process because it provides motivation for activity, increases interest, generates curiosity, make connections to prior knowledge and strengthen learning objectives and criteria for success in teaching. Martin-Hansen (2002) noted that although inquiry can be applied to other disciplines, it is more appropriate to teaching of sciences, hence it is effective for Chemistry teaching and learning since Chemistry is inquiry in nature.

Jensen (2008) stated that inquiry strategy promotes learning and achievement more in science, encourages team spirit which is an attribute of science. To achieve a successful teaching through inquiry strategy, certain procedures are considered, these procedures are what Saskatchewan (2010) called inquiry approaches which the teacher should:

- Present a problem or puzzling situation that stimulates interest.
- Ensure that students understand the problem or event of situation.
- Either structure the lesson to develop specific predetermined generalization thereby limiting the number of generalizations developed (guided inquiry) or

- Identify general problem or question but not specific generalization to be developed, thereby allowing unlimited number of generalizations to be developed (unguided inquiry).
- Provide and structure appropriate materials, equipment, data, classroom and environment.
- Provide instruction about whether students work alone or in groups.
- Either act as class leader throughout the lesson and ask questions and suggest activities which will lead students to desired generalizations (guided inquiry) or ask only initial questions.
- Students interact with materials and with each other without further teacher's guidance
- Elicit observation and generalizations in whole class discussion or encourage individual or small groups sharing.
- Observe and listen to students throughout the lesson, note students activities, questions and hypotheses, note process which lead students to specific conclusions.

The above approaches include both guided and unguided inquiry. The teacher may decide on which type of inquiry to apply. However, whether guided or unguided, inquiry strategy has many benefits in teaching and learning. Okwor (2007) noted that the following educational benefits would be achieve by learners through inquiry strategy:

- Active participation of learners in the teaching and learning process.
- Building up self-concepts and knowledge.
- Retention and transfer of knowledge to new but similar situations.
- Arousing interest and promoting intrinsic motivation.
- Development of effective thinking, creative expression, critical analysis and logical reasoning.

How to Adapt Inquiry Instructional Strategy

Teachers play a vital role in adapting the inquiry process according to the knowledge and cognitive ability of the learners. While using inquiry strategy, teachers are responsible for the following as outlined by Onan (2012):

- Starting the inquiry process
- Promoting student dialog
- Transitioning between small groups and classroom discussions
- Intervening to clear misconceptions or develop students' understanding of material
- Modelling scientific procedures and attitudes
- Utilizing students experiences to create new knowledge.

Regardless of how much guidance and assistance the teacher provides, the fundamental goal of inquiry is student engagement during learning process. The activity finishes by the creation of a new knowledge which tries to answer the initial questions.

Villavicencio (2000) outlined five steps to be taken during strategic cycle which was adopted in this study as illustrated in Figure 2.1

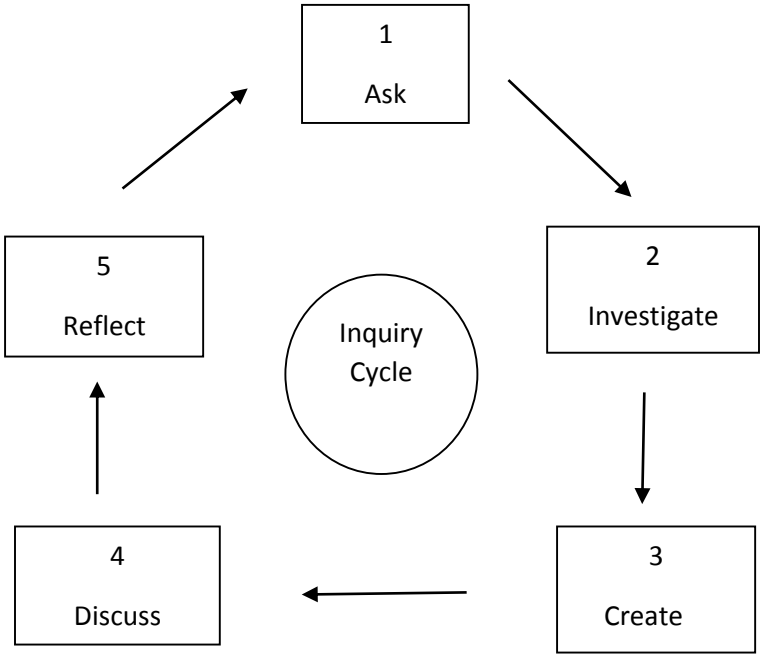

Figure 2.1 showing the inquiry cycle that was adopted for teaching using guided inquiry strategy as outlined by Villavicencio (2000).

Upon incorporating inquiry cycle into a classroom, teacher should ensure that each of the five steps of inquiry cycle is complete.

The five steps of inquiry process are briefly explained as follows:

1. Asking: This is the first step of inquiry cycle. It begins with students' curiosity of questioning about a given phenomenon. The teacher can stimulate the students' curiosity by giving an introduction relevant to the concept under investigation. This step give attention on a question that students begin to define which is redefined again during the cyclic process of inquiry.
2. Investigation: Asking a question naturally leads to investigation that will feat initial curiosity that bring about construction of information. The information collected by the student is then redefine through modifying the question thereby making it clearer.

3. Creation: At this step, students begins to synthesize the information collected thereby making links in order to create new knowledge. Students may generate new ideas, thoughts and theories that are not directly stimulated by their experiences.
4. Discussion: Here, students share their knowledge, ideas or thoughts with each other and ask about others own investigation and experiences. This sharing of knowledge and experiences is a process of construction and understanding of their investigation.
5. Reflecting: This step emerge the final stage of inquiry process where students take time to look back and rethink about the initial question, procedure followed and the conclusions made from which they may take some new decisions by posing a question like: Has a solution been found? Has new question appear?

With respect to the present study, guided inquiry entails instructional process where the search for knowledge is initiated by the teachers' questions. The teacher also provides assistance to learners during teaching and learning process to enable the learners construct meaningful knowledge. In guided inquiry strategy, teacher and learners play a fundamental roles in asking questions, developing answers and procedures that will enable effective learning to take place. Campbell (2006) defined guided inquiry as a range of investigative planned activities where an instructor provides problem or question and encourages learners to work out procedure for solving the problem or answering the question. The following are the process of guided inquiry:

- It provides students with direction towards information location
- It ensures success in the discovery of concepts and principles due to guidance and direction provided by the instructor
- The structured question make the students to think critically and analytically
- It also helps students to organize and facilitate learning

- It also ensures that students do not get frustrated and experience failure in the learning process
- It also connects the curriculum content to the learners' domain

2.8 Academic Achievement and Motivation in Chemistry

Academic achievement is usually measured by continuous assessment or terminal examinations in a school setting. Academic achievement according to Obeka (2010) is the quality of a result produced by students which has bearing on the quality of scores in their examination. Academic achievement is the actual mark obtained by students in the examination which is used to measure the level of students' cognitive ability. Motivation according to Awan, Noureen and Naz (2011) is an internal condition that stimulates, maintains and direct a behaviour and they also believe that there is a strong relationship between learning and motivation. What students do or learn will in one way or the other have influence on their learning as a result of motivation as pointed out by Pintrich and Schunk, (2002). They regarded motivation as an integral part of learning and those students who are motivated to learn a particular topic would be found in an activities that will help them to learn, such as taking class notes, attending lessons and asking for help where they do not understand. According to Tella (2007), motivating learners is an essential part of an effective learning. Effective learning will not take place satisfactorily in the absence of adequate motivation of students to learn. However, it is assumed that people differ in their need to achieve something in a situations that regards on excellence as stated by Muola (2010). The need to achieve varies from one individual to another. Muola (2010) added that those students who have high achievers as their role models in their early life experiences would develop high need for achievement while those who have low achievers as their role models would hardly develop need for achievement.

2.9 Gender Issues in Teaching and Learning Chemistry

Gender is a socio-culturally constructed concept of assigning some characteristics and roles to sex such as male and female within the society. The concept of gender is equivalent to class and race and has many social construct just as class and race (Robert, 1996). Okeke (2007) observed that the circumstances of gender have strongly interacted with culture to produce sex role-stereotypes which cut across social, economic, political and educational development especially in the areas of science and technology. Nzewi (2010) explained sex role-stereotypes as the socio-cultural classification of human activities by sex in line with what the society considers as appropriate for one sex or the other.

The arbitrary assigning of roles and expectations to different sex (male and female) within the society has given rise to such misconception of perceiving science as masculine and of male domain only. Oludipe (2012) observed that in Nigeria, certain vocations and professions like Medicine, engineering and architecture have traditionally been regarded for men and others like nursing, catering, typing for women. The society's socio-cultural construct of females as weaker sex together with females self-perception of themselves as weaker sex, inferior and subordinate to the males have impose some socio-cultural limitations on female aspirations and achievement in sciences (Ojobo, 2008). Similarly, Nzewi (2010) inferred that the socio-cultural upbringing of females within most Nigerian homes tends to shape the girl-child away from science and science related disciplines. For instance in most families what are regarded as complex and difficult tasks are allocated to boys whereas girls are expected to handle the relatively easy and less demanding tasks. Consequently fewer females option for science subjects thereby creating some differences in the number of males and females in science discipline in favour of the males.

However, Chang (2003) reported that although there is a decrease in the gap in gender difference in student achievement in sciences, but female representation in sciences is still low in comparison with their male counterparts. Gender issues and its effects in students' academic achievement and motivation in science has been persisted over the years with contradicting results and stands out as a controversial issue in science education due to varying reports from different researchers. Some researchers like Ibe (2004); Iweka (2006); Obiekwe (2008); kolawole (2007 and Okoro (2011)) are of the view that males perform better than females in sciences whereas some educators like Okeke (2007), Nzewi (2010) and Oludipe (2012) are of the view that both males and females achieve equally in science when given equal opportunity and facilities.

Nevertheless, Okoro (2011) specifically maintained that some teaching methods that involve students' competition such as individual learning favours male students more than female students while those other teaching methods that encourages group work such as inquiry learning favours females more than males. However, this report may be in line with observations of Nzewi (2010) which stated that males tend to be dominating in competitive activities while females are always shy and may prefer working in group or under male counterparts .In view of the inconclusive issues of the effects of gender on academic achievement and motivation and some reports that innovative teaching methods influence gender, academic achievement and motivation in Chemistry, this study therefore intend to contribute to the on-going academic argument and controversy on the effects of gender on students' academic achievement and motivation by investigating the effectiveness of guided inquiry strategy to determine the interactive effect of the method and gender on students' achievement and motivation in Organic Chemistry.

2.10 Review of Related Empirical Studies

Uzezi and Zainab (2017) conducted a research on effectiveness of guided-inquiry laboratory experiments on senior secondary school students' academic achievement in volumetric analysis. The study was carried out in Jalingo, Taraba state, Nigeria. The study was aimed at investigating the effects of guided-inquiry laboratory experiments on secondary school Chemistry students. Quasi-experimental design was used for the study. Two research questions were raised to guide the study. A total of 144 SS II Chemistry students served as the sample of the study, 75 were used in the experimental group and 69 for control group. Volumetric Academic Achievement Test (VAAT) with a reliability coefficient of 0.80 and a lesson plan were used as instrument for data collection. Mean, t-test, SPSS and ANCOVA are the statistical tools for data analysis. Findings showed that guided-inquiry laboratory experiment have significant effect on students' achievement than traditional method. It also revealed that gender has no significant effect on students' achievement from the instructional approaches. The researcher further recommend that guided-inquiry experiment should be incorporated into teaching and learning process since it developed students practical and foster the spirit of competitiveness among the students. The reviewed study is found almost the same as the present one in terms of objectives, gender and nature of students used for the study but however differs in the concept being used. The reviewed study uses volumetric analysis but the present study will involve the use of organic chemistry concept. The effect of motivation on students' academic achievement will also be investigated in the on-going study.

Sen and Oskay (2017) carried out a research on the effect of 5E inquiry learning activities on achievement and attitude of students towards Chemistry. The objective of the investigation was to determine the effect of 5Einquiry learning on achievement and attitude of students towards

Chemistry. Two research questions and two hypotheses guided the study. A non-equivalent quasi experimental research design was employed for the study. A total of 34 (8 males and 26 females) undergraduate volunteers in Turkey serves as the sample of the study. The study uses one experimental group and one control group. The experimental group was treated using 5E inquiry learning while the control group receives the normal conventional method of teaching. A fully validated instrument titled Chemical Equilibrium Concept Test (CECT) with a reliability coefficient of 0.73 and Attitude toward the subject of Chemistry inventory (ASCI) were used for data collection. The data obtained was analyzed using independent t-test. The findings revealed that 5E inquiry learning activities were more effective in improving the achievement in chemical equilibrium compared to conventional lecture method, the result also revealed that there is no statistically significant mean difference between experimental and control groups with respect to attitude toward Chemistry. The researchers goes further to recommend that 5E inquiry learning should be incorporated in the school curriculum and science teachers should endeavor to use 5E inquiry learning in order to improve students' academic achievement. The reviewed study use 5E inquiry learning but the current study is using the normal inquiry instruction. In the reviewed study, chemical equilibrium concept was used to teach undergraduate students in Turkey which differs from the on-going study that will make use of organic chemistry concept to teach SS II chemistry students in Nigeria. The present study will also find the effect of gender and motivation on students' academic achievement towards organic chemistry.

Ural (2016) investigated a study on the effect of guided-inquiry laboratory experiments on Chemistry students' achievement, laboratory attitudes and anxiety. The study was carried out in Turkey, aimed at determining the effect of guided-inquiry on students' attitudes towards Chemistry laboratory activities, students' anxiety and their academic achievement in Chemistry. Quasi-

experimental research design was used and 37 third year undergraduate science education students were involved in the study. A semi-structured interview, Chemistry Achievement Test (CAT), Chemistry Laboratory Attitude Scale (CLA) and Chemistry Laboratory Anxiety Scale (CLA x) were used as instruments for data collection. The scales are a five point Likert type scales with a reliability co-efficient of 0.85 and 0.88 respectively. Paired sample t-test has been used for data analysis. Findings of the study showed that guided-inquiry laboratory experiments develop positive attitudes towards Chemistry laboratory activities and decreased students' anxiety level. The result also revealed that from the responses obtained from the interview, students have positive views associated to the influence of inquiry method. The result also has shown that students' achievement in the guided-inquiry presentation was meaningfully greater than their achievement in traditional setup. The researcher further recommend that science education students should search actively and participate in inquiry-based laboratory experiments instead of cook book style experiments. The reviewed study investigated the effects of attitudes and anxiety of undergraduate science education students in Turkey while in the present study, effects of motivation and gender on SS II Chemistry students' academic achievement will be investigated in Nigeria.

Duran and Dokme (2016) investigated the effect of inquiry-based approach on students critical thinking skills, conducted in Mugla, Turkey, with a view to determine the effect of an activity set developed according to the inquiry-based strategy. The research design used was semi-experimental, 90 students of 6^{th} grade secondary school of Mugla were involved in the study. Two groups were used, experimental group where students were taught through inquiry instruction and control group taught using lecture method. In the study, Critical Thinking Skills Scale and Critical Thinking Questionnaire with a reliability coefficient of 0.93 were used as instrument for data collection. The study uses ANCOVA and SPSS to analyze the data. Findings showed a significant

difference between the critical thinking skills of experimental group and control group of students ($p < .05$). The result also revealed that the mean score of experimental group is higher than that of control group. The researchers concluded that inquiry instruction is more effective in improving students' critical thinking level. The researchers further recommend that guided-inquiry teaching materials should be made available to both students and science teachers in order to enhance students' critical thinking abilities. The present study is unique in terms of these variables gender and motivation that make it different from the reviewed study which was focused on sixth grade students' critical thinking skills. The present study will also examine the effect of guided inquiry instruction on the academic achievement of SS II Chemistry students. The reviewed study was conducted in Turkey using 6th grade students while the present study will be conducted in Nigeria using Chemistry students.

Lucy (2015) conducted a study on effects of inquiry method on academic achievement of chemistry students in senior secondary school Kaduna state, Nigeria. The objectives of the study was to determine the effects of guided inquiry on the academic achievement of secondary school students in Kaduna state. To guide the study, four (4) research questions were paused and four (4) corresponding hypothesis were raised and tested at 0.05 significant level. The design of the study was quasi-experimental design. The population of the study comprised all chemistry students in government owned secondary schools in Kaduna. The sample size of the study was 120 SS II chemistry students and was selected using random sampling technique involving balloting. Chemistry Achievement Test (CAT) was used as instrument for data collection. The reliability co-efficient of CAT was 0.89. Mean, standard deviation and t-test was used to analyze the collected data. The result of the study revealed that chemistry students taught using inquiry method perform better than those taught using conventional method. The study concluded that inquiry method

improves students' achievement in chemistry. Based on the findings of the study, the researcher recommended that inquiry method should be used in teaching chemistry. The reviewed study is quite similar to the present study in terms of objectives, research design, sampling technique, only that it does not involve the effect of gender with respect to students' academic achievement and motivation toward Organic Chemistry. The reviewed work was investigated in Kaduna state using all Chemistry students while the on-going study will be conducted in Katsina state using only SS II Chemistry students specifically in Organic Chemistry.

Hashim, Abakar & Ahmad (2015) investigated a research on the effect of inquiry-based science teaching on junior secondary school students' academic achievements in Jigawa state, Nigeria. The aim of the study was to determine the effects of inquiry instruction in teaching science in JSS 3 in Jigawa. Four research questions and four hypothesis were formulated to guide the study. Randomized experimental research design was employed. All JSS 3 students served as the population of the study, out of which 300 students were selected using random sampling technique to serve as the sample size. Inquiry-Based Science Teaching Achievement Test (ISTAT) and Students' Attitude Questionnaire were used as instrument for data collection. The data was analyzed using t-test and Pearson product moment correlation coefficient (r).Findings revealed that students taught with inquiry method have higher academic achievement than students taught through conventional method. The researchers concluded that inquiry instruction develops students' achievement in Science. Based on the findings, the researchers further recommend inquiry method as the best way in teaching of science. The reviewed study use Junior Secondary school students in teaching science while the on-going study will use SS II students to teach Organic Chemistry. The present study is also unique as it contains motivation and gender as a

variables which are not considered in the reviewed work. The current study will be carried out in Katsina state unlike the reviewed study that was conducted in Jigawa state.

Maxwell, Lambeth and Cox (2015) conducted a study on effects of inquiry instruction on science achievement for 5th grade students in USA. The study was aimed at examining the effects of inquiry instruction on the academic achievement, attitudes and engagement of 5th grade science students. Three research questions were asked to guide the study. Quasi-experimental design was used. A total of 42 fifth-graders served as the sample of the study where 22 students were used for experimental group and 20 for control group. Paired sample t-test, Physical Science Knowledge Assessment (PSKA), Survey of Science Attitudes (SSA) scale and checklist were the instruments for data collection. The findings indicated that pretest scores for both inquiry and traditional groups were lower than the posttest scores. The scores revealed that students who received inquiry instruction made minimal gains in achievement compared to those who received traditional teaching method. The researchers concluded that students in inquiry instruction group showed an increase in academic achievement, attitudes and engagement. The researchers further recommend that students who were given the opportunity to use inquiry-based strategies in science began to use them in other areas of study. The reviewed study was not specific in what was taught in teaching primary school students science whereas the on-going study will be focused on Organic Chemistry and SS II Chemistry students will be used. Motivation and gender as a determining factor for students' academic achievement also make the present study differ from the reviewed one. The reviewed study was conducted in USA while the current study will be investigated in Nigeria.

Abdi (2014) carried out a research on the effect of inquiry instruction on students' academic achievement in science course. The study was conducted in Kermanshah, Iran. The aim

was to investigate the effect of inquiry instructional strategy on science students' academic achievement in Kermanshah, Iran. One research question and its corresponding null hypotheses was formulated in order to guide the study. The study adapted quasi-experimental research design. Fifth grade primary school students of Kermanshah served as the population of the study and 40 students were sampled selected using purposive sampling technique. A validated Academic Achievement Test with reliability coefficient of 0.75 was used as the instrument for data collection. The statistical tools used were Mean, standard deviation and Analysis of Variance (ANCOVA). Findings indicated that higher achievement was observed in students taught with inquiry method than those taught using lecture method. It is concluded that inquiry instruction is more effective in improving students' academic achievement. The reviewed study did not measure whether if inquiry approach has effect on students' gender which the present study will consider by determining its effectiveness in bridging the gap between academic achievement and motivation of male and female students. The on-going study will be conducted in Nigeria using SS II Chemistry students and also specific in Organic Chemistry which also differs from the reviewed study that was conducted in Iran using Fifth grade primary school students.

Njoroge, Changeiywo and Ndirangu (2014) investigated a study on the effects of inquiry instructional approach on secondary school students' achievement and motivation in physics in Nyeri County, Kenya. The objective was to find out the effects of inquiry instruction on physics students' achievement. Quasi-experimental research design was adapted for the study. A total of 370 physics students were involved in the study. The research instrument used was a Physics Achievement Test (PAT) with a reliability coefficient of 0.87. The data obtained was analyzed using t-test, ANOVA and ANCOVA at 0.05 significant level. The findings showed that inquiry instruction bring about higher test scores of physics students. The reviewed work and the present

study are similar in terms of their objectives and research design, however the reviewed study was carried out in Nyeri County, Kenya using Physics students while the present study will be conducted in Nigeria using Chemistry students. The on-going study will also look into the effect of gender on students' achievement when exposed to inquiry instruction which was not considered in the reviewed study.

Sola and Ojo (2007) conducted a research on the effects of project, inquiry and lecture-demonstration methods on senior secondary students' achievement in separation of mixtures in Osun state, Nigeria. The purpose of the study is to assess the effectiveness of using project, inquiry and lecture methods of teaching experimental aspects of Chemistry. To guide the study, four (4) research questions with their corresponding null hypotheses were raised. Quasi-experimental research design was employed for the study. A total of 233 Chemistry students of senior secondary school 1 (SSS 1) were randomly selected as the sample of the study. Three experimental groups and one control group were used in the study. The experimental groups were treated using project, inquiry and lecture-demonstration methods while control group receives the normal conventional method of teaching. A fully validated instrument titled Chemistry Achievement Test (CAT) was used for data collection. The data was analyzed using t-test, Analysis of Variance (ANOVA) and Schaffer post-hoc analysis. Findings revealed that project method brings about a significant different in the achievement of students in experimental group, thus students taught using project method performed better than those taught with inquiry and lecture-demonstration methods. The study concluded that project method improves students' academic achievement in Chemistry practical over inquiry or lecture-demonstration methods. The reviewed study compared three methods of instruction which make it different from the present study that will explore only inquiry method. The present study will also explore the effect of inquiry instruction with respect to gender

and also the effect of motivation towards Organic Chemistry. The reviewed study used SS I students in Osun state while the on-going study will be conducted in Katsina state using SS II Chemistry students.

Tuan, Chin, Tsai & Cheng (2005) conducted a study on the effectiveness of inquiry instruction on the motivation of different learning style students in China province. Quasi-experimental design was used, 254 8^{th} graders were used as experimental group and 232 were used as control group. A research instrument titled students' motivation towards science learning questionnaire (SMTSL) with reliability coefficient of 0.78 was used for data collection. The data obtained was analyzed using t-test, MANOVA and analytic inductive method. Findings of the study indicated that after inquiry instruction, students' motivation increased significantly ($p < .001$) than students who were enrolled in traditional teaching. It revealed that four (4) different learning styles of students increased significantly. It also revealed that no significant different was found among the four learning styles of students' motivation after inquiry teaching. Findings confirmed that inquiry instruction can motivate students with different learning styles in science teaching. The reviewed work is similar to the present study in terms of teaching method and instrument used but differs in the geographical location, time and nature of students. The study reviewed was carried out in China with 8^{th} graders students while the on-going study will be investigated in Katsina State, Nigeria, with SS II senior secondary students and also specific in Organic Chemistry. The present study will also enroll the effect of gender on students' academic achievement that is not included in the reviewed study.

2.11 Implications of Literature Reviewed for the Present Study

The review of relevant literatures revealed that Conventional Lecture method of teaching chemistry has not produced the anticipated result hence the need for a result oriented method such as inquiry strategy which is found to be an effective instructional methodology where students actively participate during learning. This is equivalent to the research findings in diverse areas of science education concepts across the world at different levels of educational institutions. For example, Abdi (2014) carried out a study on the effect of inquiry-based approach where he uses 5^{th} grade primary school pupils and obtained a result similar to that of Hashim, et al (2015), Lucy, (2015), Sen & Oskay (2017), Tuan, et al (2005), Uzezi and Zainab (2017) and Njoroge (2014). These are studies investigated in junior or senior secondary schools or undergraduate students of universities. All the findings confirmed inquiry strategy improves students' academic achievement through active involvement and manipulation of instructional materials at the course of instruction. The present study will emphasize on using guided inquiry strategy to see how it can enhance students' academic achievement and motivation in Organic Chemistry.

The literature reviewed regarded lecture method of teaching as an approach that resulted in low academic achievement of students when applied in teaching science, thus call for the need to bring about practically oriented Strategy like inquiry strategy for better attainment of educational goals and objectives. The contributions of Duran & Dukme (2016), Maxwell, et al (2015), Tuan, et al (2005) and Ural (2016) indicated that inquiry strategy enhanced learning of Chemistry concepts effectively and therefore should be employed as an appropriate method of instruction in science education. Thus the present study seeks to investigate the effects of guided inquiry strategy on academic achievement and motivation of Secondary School students in Organic Chemistry.

It shows from the available literature that, if students are taught with guided inquiry strategy, their academic achievement and motivation in Organic Chemistry will increase and this type of research has not been conducted in Musawa, Katsina State. Therefore, the researcher investigated the effects of guided inquiry strategy on academic achievement and motivation in Organic Chemistry among Senior Secondary School Students in Musawa, Katsina State.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This study examined the Effects of Guided Inquiry on Motivation and Academic Achievement in Organic Chemistry among Secondary School Students in Musawa, Katsina State. This chapter focuses on the following sub-headings: Research Design, Population of the Study, Sample Size, Sampling Technique, Data Collection Instruments, Validity of the Instruments, Reliability of the Instruments, Data Collection Procedure and Data Analysis Procedure.

3.2 Research Design

The design used for this study was quasi-experimental research design, involving pre-test and post-test experimental and control groups. The design consist of two schools. One school was used as experimental group and the other school as control group. The experimental and control groups were pre-tested with Organic Chemistry Achievement Test (OCAT) to determine the group equivalence at the beginning of the testing. Treatment was given to the experimental group by exposing the students to Organic Chemistry Concepts using guided inquiry strategy and control group was taught Organic Chemistry concept using lecture method for a period of six weeks. After the treatment period, post-test was administered to both groups. A rating scale was also administered to measure students' motivation before and after the treatment. The scores from the groups were collected and analyzed to determine the differences in the mean scores of students using SPSS.

The design used for this study is illustrated in Figure 3.1

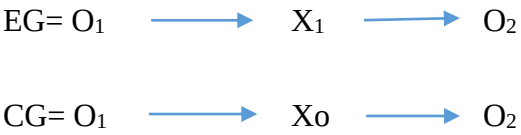

Figure 3.1: Research Design Illustration

Where:

EG= Experimental Group

CG= Control Group

O_1= Pre-test for Experimental and Control Groups

O_2=Post-test for Experimental and Control Groups

X_1= Treatment with Guided Inquiry Strategy for Experimental Group

Xo= Lecture method for Control Group

3.3 Population of the Study

The population of the study comprised of 495 SS II Chemistry students with an average age of 16 years old. The schools used were mixed public senior secondary schools in Musawa, Katsina State. The major tribe of the students is predominantly Hausa/Fulani. There are ten (10) co-educational public senior secondary schools that are offering Chemistry in Musawa as illustrated in Table 3.1.

Table 3.1 Population of the Study

S/N	Name of School	Location	Gender		Total
			M	F	
1.	School A	Urban	28	17	45
2.	School B	Urban	21	16	37
3.	School C	Rural	20	15	35
4.	School D	Rural	22	11	33
5.	School E	Rural	35	13	48
6.	School F	Rural	28	15	43
7.	School G	Rural	30	14	44
8.	School H	Urban	97	24	121
9.	School I	Rural	36	17	53
10.	School J	Rural	23	13	36
		Total	**340**	**155**	**495**

Source: Musawa Zonal Education Quality Assurance Office (2017), Katsina State Ministry of Education.

3.4 Sample Size

A sample of 72 SSII Chemistry students drawn from the sampled schools were used for this study. Two schools were sampled from the population of the study. The sampled schools were School B having a total of 37 Chemistry students (21 males and 16 females) and School C with a total of 35 Chemistry students (20 males and 15 females).

Table 3.2 Sample of the Study

S/N	Name of School	Male	Female	Total
1	School B (Control Group)	21	16	37
2	School C (Experimental Group)	20	15	35
	Total	41	31	72

3.5 Sampling Techniques

Simple random sampling technique via balloting was used to select the sampled schools among the ten (10) Co-educational public Secondary Schools in Musawa. This is done in order to side step unfairness. Intact classes from each sampled school were also prepared and used for the study. The sampled schools are: school B and school C. School C was randomly assigned as experimental group and School B was randomly assigned as control group each having a total of 35 and 37 Chemistry students respectively.

3.6 Selection of the Topic Taught

The concept of Hydrocarbons (i.e. Alkanes, Alkenes and Alkynes) is chosen because of the fact that Organic Chemistry is part of SS II Chemistry syllabus and also identified among the difficult concept (WAEC 2013). Hydrocarbon is the part of Organic Chemistry that laid a solid foundation to the study and understanding of Organic Chemistry due to its importance in Chemistry in the field of Science and other Science related disciplines.

3.7 Data Collection Instruments

Organic Chemistry Achievement Test (OCAT) and Students' Motivation Rating Scale (SMRS) were used as instruments for data collection. The researcher adapted the items of the instrument (OCAT) from the past WAEC and NECO (2017, 2016, 2015, 2014 & 2013) Chemistry question papers that are relevant to the Organic Chemistry. The achievement test contains 30 items objectives questions with four (4) options lettered A-D. One mark is assigned for each question from which the students were asked to circle the correct option. Marking scheme for Organic Chemistry Achievement Test (OCAT) was prepared to help in marking the test while Students' Motivation Rating Scale (SMRS) was adapted from Glynn and Koballa (2006) which was also used to measure students' motivation towards Organic chemistry. The SMRS consist of a 4-point Likert-scale responses (i.e. strongly agree, agree, disagree and strongly disagree). The 4-point Likert-scale is scored 4 for Strongly Agree, 3 for Agree, 2 for Disagree and 1 for Strongly Disagree.

Test on Blooms' Taxonomy for OCAT was developed by the researcher and was used to decide the number of items for a particular topic. The instrument was developed based on the six Blooms' Taxonomy of Educational Objectives. The items in the instruments were distributed as follows: knowledge has 12 questions, comprehension 10 questions, application 3 questions, analysis 4 questions, synthesis 0 question and evaluation 1 question. The distribution of items is presented in Table 3.3

Table 3.3: Test on Blooms' Taxonomy for OCAT construction

Contents	weight. (100%)	Know. (40%)	Comp. (30%)	Appl. (10%)	Anal. (13.3%)	Synth. (0%)	Eval. (3.3%)	Total (100%)
1. General Hydrocarbons	40	4	4	1	2	0	1	12
2. Alkanes	23.3	3	2	1	1	0	0	7
3. Alkenes	30	4	3	1	1	0	0	9
4. Alkynes	6.7	1	1	0	0	0	0	2
Total	(100)	12	10	3	4	0	1	30

3.8 Validity of Research Instruments

Organic Chemistry Achievement Test (OCAT) and Students' Motivation Rating Scale (SMRS) were validated by experts which comprised one professor from the Department of Science and Technology Education, Bayero University, Kano, one senior lecturer from Chemistry Department, Umaru Musa Yar'adua University, Katsina and one experienced Graduate Chemistry teacher with ten years teaching experience at GSSS Dutsinma. The validators were asked to determine:

(a) The appropriateness of the instrument with respect to the objectives of the study.

(b) Grammatical structure of the questions, clarity and ambiguity of the instrument.

(c) Scope of the questions with reference to the content of the instrument

(d) Suitability of the questions to the comprehension level of students

The researcher had effected all corrections and suggestions made by the validators in order to enhance the validity of the research instruments (see Appendix IX).

3.9 Reliability of Research Instruments

Organic Chemistry Achievement Test, OCAT and Students' Motivation Rating Scale, SMRS were administered in one of the secondary schools that is outside the sample of the study for pilot testing. To establish the reliability of the instruments, OCAT was administered twice at an interval of two weeks using test retest method. The scores of the first and second test for OCAT were compared using Pearson Product Moment Correlation (PPMC) and the reliability co-efficient of 0.80 was obtained which indicated a high reliability index (see Appendix X). This means, there is a strong relationship between the first test scores and the second test scores whereas SMRS was also administered to SS II students where a split-half coefficient of 0.70 was obtained using Mann-Whitney. This implies that, both instruments (OCAT and SMRS) are considered to be reliable.

3.10 Item Analysis

Difficulty Index (DI)

The difficulty index of an item in a test is defined as the value obtained when an individual score on an item is divided by the total responses on that item (Dahiru, 2006). It is being calculated using the formula DI = R/T Where: DI = Difficulty Index, R = Number of Correct Responses, T = Total Number of Students. Test items with difficulty index ranging from 0.3- 0.7 are usually recommended for use.

Discrimination Index (DII)

The discrimination index is the power of each of the items to distinguish between high ability and low ability students. According to Ibrahim (2012), the Discrimination Index of a test item is the ability to separate and rank any student in a test. However, the discrimination index ranging from 0.3 and 0.7 are recommended for selecting good items for achievement test. This is calculated using the scores obtained by the top 27% and bottom 27% of the respondents.

DII = UG – LG/ ½ N

DII= discrimination index

UG= upper group 27% of respondents who scored the items correct

LG= lower group 27% respondents who scored the items correct

N= total number of respondents.

Discrimination indices ranging from 0.30 to 0.49 are regarded as moderately positive, those above 0.7 are highly positive while those below 0.19 are regarded as poor as stated by Lawal (2009).

The difficulty index and discrimination indices of the 30-items test were shown in the appendices.

3.11 Data Collection Procedure

Organic Chemistry Achievement Test (OCAT) and Students' Motivation Rating Scale (SMRS) were administered to students in the sampled schools before the treatment. At the end of the treatment which lasted for a period of six (6) weeks, posttest was administered. The scores for both the experimental and control groups were recorded. The test items in both pre-test and post-test were scored one (1) mark each and a maximum of thirty (30) marks.

The following procedures were implemented in the administration of the instruments.

Pre-Test Session: Before the real treatment, the research samples were given a pretest. The test was administered by the researcher with the assistance of Chemistry teachers in the sampled schools. The scripts were marked by the researcher. The pre-test was meant to:

* determine the students' initial knowledge about the concept to be learn later.

* compare the students entry knowledge in both schools with the concept involved in the study.

Treatment Session: Guided inquiry strategy was used to treat the experimental group. The treatment was done by the researcher. The main treatment for the study was the teaching of the concept of Hydrocarbons (Alkanes, Alkenes and Alkynes) for SS II Chemistry students. Before

the treatment started, the researcher explains to the students the processes and practices involved in guided inquiry strategy. The researcher ensured that the designed lesson plans for guided inquiry was strictly followed in teaching the concept of Hydrocarbons through the steps involved in teaching with guided inquiry strategy as outlined by Villavicencio (2000).

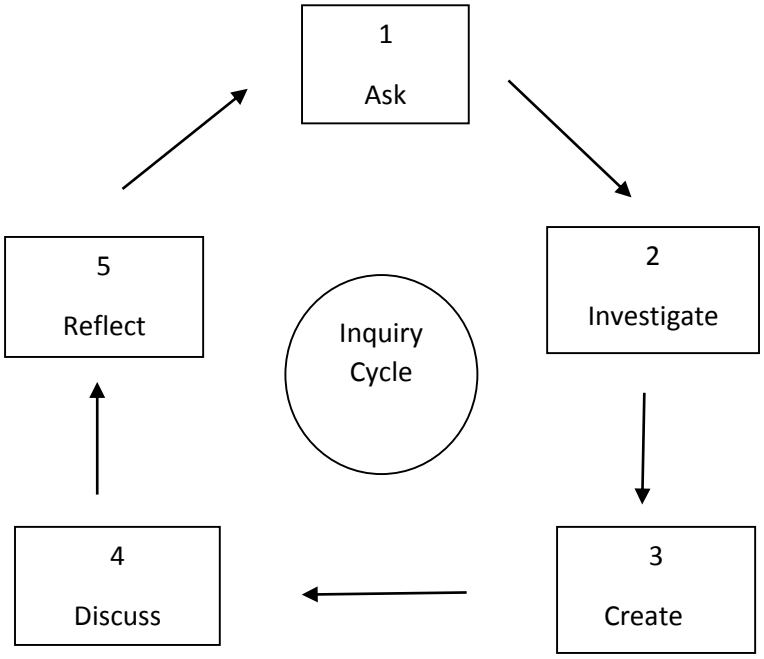

Figure 3.2 showing the inquiry cycle that was adopted for teaching using guided inquiry strategy as outlined by Villavicencio (2000).

Post Test Session: Immediately after the treatments, post-test for OCAT was administered to both experimental and control groups. The scripts of both pretest and posttest were marked and the scores were recorded by the researcher. At the same time, students' motivation rating scale (SMRS) was also administered by the researcher to measure the students' motivation level.

3.11.1 Teaching of the Control Group

Chemistry students in the control group were taught by the researcher the same concept of Hydrocarbons (Alkanes, Alkenes and Alkynes) using traditional lecture method. The designed lesson plans purposely prepared for control group were used in teaching the concept of Hydrocarbons. The researcher administered the achievement test (OCAT) to the students as pretest and after a period of six weeks teaching, then the researcher also administered to the students the same instrument (OCAT) as posttest. The results of both pretest and posttest scores for OCAT were marked and recorded. At the same time, Students Motivation Rating Scale (SMRS) was also administered to the Chemistry students in order to measure students' motivation level.

3.12 Data Analysis Procedure

The data obtained for this research work was analyzed using descriptive and inferential statistics. The descriptive statistics Mean and Standard Deviation were used to answer the research questions. The mean was used to show the differences in students' academic achievement between the two groups while standard deviation indicated how academic achievement of students were closely related. The inferential statistics used were Z-test and Mann-Whitney (U-test). These statistics (Z-test and U-test) were used in testing the formulated null hypotheses. Z-test was used because the population sample was large. Usually a sample that is less than 30, t-test is used but in a situation where the sample is above 30, Z-test is being employed. While U-test was used in testing the null hypotheses three and four because the variable motivation is discrete.

CHAPTER FOUR

DATA PRESENTATION AND ANALYSIS

4.1 Introduction

In this chapter, the data obtained were analyzed, discussed and presented. The chapter was discussed under the following sub-headings: Data Presentation and Answering the Research Questions, Hypotheses Testing, Summary of the Findings and Discussion of the Results.

4.2 Data Presentation and Answering the Research Questions

The results of the study were presented according to the Research Questions and Hypotheses stated in chapter one. The data were obtained using Organic Chemistry Achievement Test (OCAT) and Students' Motivation Rating Scale (SMRS).

Research Question One: What are the mean achievement scores of students taught Organic Chemistry using guided inquiry strategy and those taught using lecture method?

To answer research question one (1), the post test scores of students in the experimental and control groups were subjected to descriptive statistics in form of Means and Standard Deviations which is presented in Table 4.1

Table 4.1: Analysis of the Post Test Means and Standard Deviations Scores of the Experimental and Control Groups

Groups	N	Mean	S.D	Std. Error	Mean Difference
Experimental	35	21.46	2.72	0.46	7.35
Control	37	14.11	2.97	0.48	

Table 4.1 revealed that the means and standard deviations of post test scores for experimental group was 21.46 with standard deviation of 2.72 while control group had a mean of 14.11 with standard deviation of 2.97 respectively. Mean difference between the two groups is 7.35 which shows that the two groups were different in academic achievement. This shows that Organic Chemistry students taught using guided inquiry strategy achieved higher than their

counterparts taught using lecture method. Scores in experimental group differed from the mean score with standard deviation of 2.72 than the control group scores with standard deviation of 2.97. However, the standard deviation 2.72 of the experimental group significantly indicated that students' academic achievement in the test are closely related compared with that of control group.

Research Question Two: Is there any difference in academic achievement between male and female students when taught Organic Chemistry using guided inquiry strategy?

To answer research question two (2), the post test scores of male and female students in the experimental group were subjected to descriptive statistics in form of Means and Standard Deviations which is presented in Table 4.2

Table 4.2: Analysis of Post Test Means and Standard Deviations Scores of Male and Female Students in the Experimental Group Exposed to Guided Inquiry Strategy

Gender	N	Mean	S.D	Std. Error	Mean Difference
Male	20	21.55	2.87	0.64	
					0.22
Female	15	21.33	2.58	0.67	

Table 4.2 indicated the means and standard deviations scores of male Chemistry students of experimental Group in post-test as 21.55 and 2.87 as well as the means and standard deviations of female Chemistry students as 21.33 and 2.58 with their mean difference of 0.22. The results showed that male Chemistry students performed approximately in the same range with their female counterpart. But however, male academic achievement in the experimental group indicated that their test scores are closely related when compared with their female counterpart with a standard deviation of 2.58.

Research Question Three: What is the Motivation level of students taught Organic Chemistry using guided inquiry strategy?

To answer research question three (3), the pre-test and post test scores of Organic Chemistry students in the experimental group were subjected to descriptive statistics in form of Mean Ranks which is presented in Table 4.3

Table 4.3: Analysis of the Pretest and Post Test Mean Rank Scores of the Experimental Group

Test	N	Mean Rank	Mean Rank Difference
Posttest	35	52.60	
			34.20
Pre-test	35	18.40	

Table 4.3 above shows that, the mean ranks of the Post Test in Experimental group is 52.60 and that of Pre Test is 18.40 having a mean rank difference of 34.20. The Motivation level of Chemistry students exposed with guided inquiry strategy is higher in Post Test than the level of Motivation of Chemistry students in Pretest.

Research Question Four: Is there any difference in Motivation level between male and female students when taught Organic Chemistry using guided inquiry strategy?

To answer research question four (4), the post Test scores of male and female students in the Experimental Group were subjected to descriptive statistics in form of Mean Ranks which is presented in Table 4.4

Table 4.4: Analysis of Post Test Mean Rank Scores of Male and Female Students in the Experimental Group Exposed to Guided Inquiry Strategy

Gender	N	Mean Rank	Mean Rank Difference
Male	20	17.03	
			2.27
Female	15	19.30	

Table 4.4 displayed the mean rank scores of male and female Chemistry students in Post Test exposed with guided inquiry strategy as 17.03 and 19.30 for male and female Chemistry

students respectively. The mean rank difference is 2.27, which shows that the Motivation level of Chemistry students exposed to guided inquiry strategy is affected by gender.

4.3 Hypotheses Testing

The following null hypotheses were tested at 0.05 level of significance.

H_O1: There is no significant difference in the academic achievement of students taught Organic Chemistry using guided inquiry strategy and those taught using lecture method.

To test $H_{01,}$ the post test data of students' academic achievement in the experimental and control groups were subjected to z-test statistics with the aid of SPSS package (version 20). The summary of the analysis is presented in Table 4.5

Table 4.5: Z-test analysis of the Post Test Mean Scores of the Experimental and Control Groups

Groups	N	Mean	S.D	Z-cal	P-value
Experimental	35	21.46	2.72	10.94	0.000
Control	37	14.11	2.97		

Table 4.5 shown that the z-value calculated is 10.94 and the p-value of 0.000 is observed. Since the observed p-value of 0.000 is less than the alpha value of 0.05, the null hypothesis one (1) which says there is no significant difference in the academic achievement of students taught Organic Chemistry using guided inquiry strategy and those taught using lecture method is therefore rejected. This implies that there is significant difference in the academic achievement scores of students taught Organic Chemistry using guided inquiry strategy and those taught using lecture method in teaching Organic Chemistry concept.

H_O2: There is no significant difference in the academic achievement scores of male and female students taught Organic Chemistry using guided inquiry strategy

To test this hypothesis, the post test scores of male and female students in the experimental group was analysed using Z-test, which is presented in Table 4.6.

Table 4.6: Z-test Analysis of Post Test Mean Scores of Male and Female Organic Chemistry Students in the Experimental Group

Groups	N	Mean	S.D	Z-cal	P-value
Male	20	21.55	2.87	0.23	0.819
Female	15	21.33	2.58		

Table 4.6 shows that the z-value computed is 0.23 and the p-value of 0.819 is obtained. Since the p-value of 0.819 is greater than the alpha value of 0.05, therefore this study accepted the null hypothesis two (2) which says there is no significant difference in the academic achievement of male and female students taught Organic Chemistry using guided inquiry strategy. This implies that both male and female Chemistry students' academic achievement are equal when exposed to guided inquiry strategy in teaching Organic Chemistry concept.

$H_0$3: there is no significant difference in the motivation level of students taught Organic Chemistry using guided inquiry strategy

To test Ho3, the post test and Pre Test scores of Organic Chemistry students in the experimental group was analysed using Mann-Whitney test, which is presented in Table 4.7.

Table 4.7: U-test Analysis of Post Test and Pre Test Mean Rank Scores of Organic Chemistry Students in the Experimental Group

Groups	N	Mean Rank	U-test	P-value
Post Test	35	52.60	14.00	0.000
Pre Test	35	18.40		

Table 4.7 revealed that the calculated U-value is 14.00 and the observed P-value is 0.000. Since the P-value observed (0.000) is less than the alpha value of 0.05, the null hypothesis three

(3) which stated that there is no significant difference in the motivation level of students taught Organic Chemistry using guided inquiry strategy is therefore rejected. This implies that there is a significant difference in the motivation level of students and that the use of motivation in teaching Organic Chemistry enhances the academic achievement of Organic Chemistry students when exposed to guided inquiry strategy.

H_O4: There is no significant difference in the motivation level of male and female students taught Organic Chemistry using guided inquiry strategy

To test this hypothesis, the post test scores of male and female students in the experimental group was analysed using Mann-Whitney test, which is presented in Table 4.8.

Table 4.8: U-test Analysis of Post Test Mean Rank Scores of Male and Female Organic Chemistry Students in the Experimental Group

Groups	N	Mean Rank	U-test	P-value
Male	20	17.03	130.50	0.558
Female	15	19.30		

The result in Table 4.8 indicated that the U-test calculated is 130.50 and P-value of 0.558 is obtained. This shows that the P-value of 0.558 obtained is greater than the alpha value of 0.05 which revealed that there is no significant difference in the motivation level of male and female Chemistry students taught Organic Chemistry using guided inquiry strategy. Therefore the stated null hypothesis is accepted.

4.4 Summary of the Major Findings

Based on the interpretation and data analysis, the following are the summary of the major findings of the study:

1. Chemistry students taught Organic Chemistry with guided inquiry strategy achieved significantly better than those taught with lecture method.
2. There is no significant difference between male and female students taught Organic Chemistry using guided inquiry strategy.
3. There is significant difference in the motivation level of students taught Organic Chemistry using guided inquiry strategy.
4. There is no significant difference in the motivation level between male and female Chemistry students taught Organic Chemistry using guided inquiry strategy.

4.5 Discussion of the Findings

Findings of research question one and hypothesis one revealed that chemistry students taught with guided inquiry strategy achieved significantly better than those taught with lecture method. This reveals that when guided inquiry strategy is employed in teaching Organic Chemistry, the strategy will improve the academic achievement and motivation of Chemistry students because Chemistry students in the experimental group were encouraged to learn by active interaction between themselves, materials and environment and this allowed them become persistent information seekers, questioners and discoverers of new knowledge. The result of the study shows that the use of guided inquiry strategy improves the academic achievement and motivation of Chemistry students.

This finding corroborate with the findings of Abdi (2014), Njoroge, Changeiywo and Ndirangu (2014) who conducted a study on the effects of inquiry instructional approach on

secondary school students' academic achievement and motivation in Physics and their findings showed that inquiry instruction brings about higher academic achievement of students than those taught using lecture method. Likewise, Ural (2016) investigated a study on the effect of guided inquiry laboratory experiments on academic achievement, laboratory attitudes and anxiety level of Chemistry students. The result of the study revealed that guided inquiry laboratory experiments have developed positive attitudes towards Chemistry laboratory activities and decreased students' anxiety level which result in greater academic achievement of students than those taught using conventional lecture method.

This finding also agrees with the work of Sen and Oskay (2017) who conducted a study on the effect of 5E inquiry learning on academic achievement and attitude of students towards Chemistry and the result of the study revealed that 5E inquiry learning is more effective in improving the academic achievement of students in chemical equilibrium when compared to those taught using lecture method. The findings of Duran and Dokme (2016) is also in agreement with the finding of this study, where they find out that there is a significant difference between the critical thinking skills of students taught with inquiry-based approach and those taught using lecture method.

This finding is also in line with that of Lucy (2015) who conducted a study on the effects of inquiry method on academic achievement of chemistry students in secondary school and find out that chemistry students taught using inquiry method perform significantly better than those taught using lecture method. This finding also agrees with the findings of Uzezi and Zainab (2017) who conducted a study on the effectiveness of guided inquiry on secondary school students' academic achievement in chemistry. Their findings showed that guided inquiry strategy have significant effect on Chemistry students' achievement than traditional lecture method.

The finding of research question two and hypothesis two shows that the academic achievement of male students taught with guided inquiry strategy did not differ with that of their female counterpart in terms of academic achievement and motivation although the same instructional strategy was employed. This is in line with the report of some educators like Nzewi (2010), Okeke (2003) and Oludipe (2012) whom are of the view that both males and females achieve equally in science particularly Chemistry when given equal opportunity and facilities. However, the work of some researchers like Kolawole (2007), Obiekwe (2008), Iweka (2006) and Ibe (2004) were of the view that academic achievement of males is better than that of females particularly in Chemistry.

The findings of research question three and hypothesis three and four indicated that Chemistry students taught with guided inquiry strategy were more motivated than those taught with lecture method. This can be confirmed by the result displayed on the table 4.7 which indicated that guided inquiry strategy increases the motivation of students in Organic Chemistry. The findings of this study agreed with the work of Opara (2011) who regarded inquiry method as a better strategy of teaching Chemistry as it promotes students' motivation through active participation of learners that bring about building up self-concepts and new knowledge in the teaching and learning process. Likewise, Nwagbo (2006), Ibe (2004) and Chukwuemeka (2005) who earlier suggested that guided inquiry learning can improve the motivation of students as it encourages active involvement and manipulation of materials which help them to become highly motivated during inquiry process. This study asserted that implementing guided inquiry strategy will result in higher academic achievement and motivation of secondary school Chemistry students.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This study examined Effects of Guided Inquiry on Motivation and Academic Achievement in Organic Chemistry among Secondary School Students in Musawa, Katsina State, Nigeria. The summary and conclusion of the whole work as well as recommendations and suggestions for further studies to be conducted in a similar or related area of the study are presented in this chapter.

5.2 Summary

This study examines the effects of guided inquiry on motivation and academic achievement in organic chemistry among senior secondary school students in Musawa, Katsina State. The significance of the study is to motivate students with difficulty in understanding the concept of Hydrocarbons. In this study, four (4) objectives were set, four (4) research questions were asked and four (4) corresponding null hypotheses were formulated. Chemistry teachers are to use guided inquiry strategy as an essential method in teaching and learning chemistry particularly organic Chemistry where Chemistry students can benefit from each other by generating new knowledge, skills and ideas gained through active participation and manipulation of the materials during inquiry process. Educators are to reflect guided inquiry strategy as an additional considerable method of teaching chemistry where students can easily comprehend what they have leant. The study was delimited to only SS II Chemistry students of the study area and the topic was restricted to Hydrocarbons.

Literatures were reviewed on Guided Inquiry Strategy, Motivation and Academic Achievement in Chemistry. Literatures on guided inquiry strategy have shown that inquiry learning occurred when students interact by coming together in order to provide solution and answers to the identified problem. It was discovered that inquiry learning as emphasized by

constructivist theory that students construct knowledge from their experiences as they are actively involved and interacted with others during inquiry learning. The related constructivist theories reviewed in this study were John Dewey and Bruner theories of constructivism, the theory of Motivation as well as Gender Schema theory.

All the mixed public senior secondary schools in Musawa were used as the population of the study. The research design used for the purpose of this study was quasi experimental research design involving pretest and posttest. There are ten (10) co-educational public Senior Secondary Schools in Musawa, from which two schools were randomly selected and served as the sample of the population. The two schools were assigned as experimental and control groups with a sample of 72 Chemistry students from (SS II Science class) of the two sampled schools was used for the study. The researcher adapted the research instruments OCAT and SMRS for data collection. Descriptive statistics involving means, mean ranks and standard deviations were used to answer research questions while Z-test and U-test using SPSS package were used to analyze the stated null hypotheses. To realize the effects of guided inquiry together with students' motivation level, academic achievement and motivation of chemistry students were measured at the beginning and after the treatment of six weeks, a post test and motivation rating scale were also administered to both experimental and control groups to determine whether guided inquiry has effect on motivation and academic achievement of chemistry students. The concept of Hydrocarbon is used because is identified as a difficult concept that result in low academic achievement and motivation of students in Organic Chemistry.

Findings of this study indicated that the academic achievement of chemistry students in experimental group is significantly better when compared with the academic achievement of students in the control group. The result of this study revealed that guided inquiry learning

improved the motivation and academic achievement of Chemistry students when compared to those taught with lecture method. The finding of this study shows that students exposed to guided inquiry strategy achieved profoundly higher than those taught using lecture method. Chemistry students taught using guided inquiry strategy were highly motivated than chemistry students taught with lecture method and also guided inquiry strategy was found to be gender friendly method of teaching Chemistry as it account for the differences in males and females Chemistry students during teaching and learning process of guided inquiry.

5.3 Conclusions

The following conclusions were made:

1. Guided inquiry strategy improves the academic achievement of Secondary School Chemistry students in Organic Chemistry.
2. Guided inquiry strategy enhances the academic achievement of both male and female Chemistry students. No gender difference exist in the academic achievement of Chemistry students taught using guided inquiry strategy.
3. Guided inquiry strategy increases the motivation of Chemistry students in Organic Chemistry concept among Secondary School students.
4. Guided inquiry strategy is a gender friendly method with regard to the motivation level of Chemistry students as it indicated that there is no significant difference in the motivation level of male and female chemistry students taught using guided inquiry strategy.

5.4 Contributions to Knowledge

The following contributions to knowledge were made by the researcher:

1. Chemistry students exposed to guided inquiry strategy achieved higher (mean=21.46) than Chemistry students taught with lecture method (mean=14.11) with a Z-score of 10.94

2. Chemistry students taught with guided inquiry strategy were significantly motivated better (mean rank=52.60) than those taught using lecture method (mean rank=18.40) having a U-test score of 14.00
3. There is no significant difference in the academic achievement between male and female Chemistry students taught Organic Chemistry with guided inquiry strategy (Z_{cal}=0.23, P=0.819).
4. There is no significant gender difference in the motivation level of Chemistry students taught Organic Chemistry with guided inquiry strategy (U-value=130.50, P=0.558).

5.5 Recommendations

Based on the findings of the study, the following recommendations were made:

1. Chemistry teachers of Secondary Schools in Musawa should teach Chemistry students with guided inquiry strategy in order to boost the academic achievement and motivation of Chemistry students.
2. Chemistry teachers should incorporate guided inquiry strategy while teaching and to shun away from using traditional lecture method of teaching as lecture method results in low academic achievement and motivation of Chemistry students because from the study, the lecture method was found to be less effective.
3. Chemistry teachers should be encouraged to use guided inquiry strategy in teaching Chemistry concepts in order to enhance the academic achievement and motivation of male and female Chemistry students during lessons.
4. Chemistry teachers should employ methods that will motivate the students during learning.

5.6 Limitations of the Study

The following are the limitations of the study:

1. Some of the students could not understand easily unless more explanations were made in their mother tongue.
2. Lack of instructional materials in the schools used which necessitated the researcher to improvise the required materials for the lessons.

5.7 Suggestions for Further Studies

The following suggestions were made from the findings of the study:

1. Related studies could be conducted on other areas of Chemistry like Mole Concept, Chemical Equilibrium, Chemical Bonding, Stoichiometry and other reported challenging areas.

2. The study titled "Effects of Guided Inquiry on Motivation and Academic Achievement in Organic Chemistry among Secondary School Students" could be carried out in other core science subjects of Biology, Physics and Mathematics.

3. The study titled "Effects of Guided Inquiry on Motivation and Academic Achievement in Physical Chemistry among Secondary School Students" could be conducted.

4. Similar studies could be conducted at NCE level and or undergraduate level.

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Appendix I

Department of Science and Technology Education,

Faculty of Education,

Bayero University, Kano.

Date: 15/08/2018

The Principal(s)
GPSSS JIKAMSHI
GDSS TSUNTSAYE

Dear Sir,

INTRODUCTORY LETTER

The bearer of this letter: **MUHAMMAD Hamza** with Registration Number: SPS/15/MST/00027 is a postgraduate student of the above mentioned department currently conducting a research titled "Effects of Guided Inquiry on Motivation and Academic Achievement in Organic Chemistry among Secondary School Students in Musawa, Katsina State, Nigeria."

Please render him all the necessary assistance he may require. All information will be treated confidentially and used only for academic purposes.

Thank you.
Yours faithfully,

Dr. Suwaiba Sa'id Ahmad
Project supervisor

Appendix II

Lesson Plan for Experimental Group

Lesson One

Subject: Chemistry

Topic: Organic Chemistry

Sub-Topic: Hydrocarbons

Class: SS II

Date: 24/09/2018

Average Age: 16+

Duration: 40 minutes

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

a. Define Organic Chemistry
b. State the Valency of Carbon atom
c. Define the term Hydrocarbon
d. Define Homologous Series.

Entry Behaviour: Recalling the physical characteristics of Organic Compounds, eliciting that they are Compounds formed by sharing of electron(s) between each atom in a covalent bond.

Lesson Presentation:

Step	Content	Teachers' Activity	Students' Activity
Ask	Introduction	Teacher introduces the lesson by explaining these concepts: Organic Chemistry, Valency of Carbon atom, Hydrocarbons and Homologous series	Students should listen to the teachers' explanation about those concepts and then ask questions based on the concepts.
Investigate	Structure of Carbon	Teacher presents to the students a chart and model of Hydrocarbons showing the Bonds between the Carbon atom and other atoms bonded to the Carbon atom	Students observe the materials available
Create	Concept of Hydrocarbons	Teacher shows to the students how to make a bond between	Students begin to link what they have already

		different atoms using ball and stick	learnt with the present situation
Discuss	Homologous series	Here, teacher make different kinds of models and ask the students to identify them	Students begin to share their ideas with others and ask others about their understanding and experiences of their investigations
Reflect	Characteristics of Homologous series	Teacher take time to look back about the initial question, procedure and steps followed and try to synthesize the concepts.	Students ask questions where they do not clearly understand

Evaluation: At the end of the lesson, teacher evaluates the students by asking the following questions:

1. What are Hydrocarbons?
2. Define Organic compounds
3. What is the valency of Carbon atom?
4. What is Homologous series?

Lesson Two

Subject: Chemistry

Topic: Hydrocarbons

Sub-Topic: IUPAC Nomenclature

Class: SS II

Date: 1/10/2018

Average Age: 16+

Duration: 40 minutes

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

1. State the meaning of the acronym IUPAC
2. Give the IUPAC rules for naming organic compounds
3. Show how to name some organic compounds
4. Give some examples of organic compounds and name them

Instructional materials: A chart of Organic compounds showing structures with their IUPAC nomenclature

Entry behavior: Review of the previous lesson, that organic compounds are formed by sharing of electrons through covalent bond

Step	Content	Teachers' Activity	Students' Activity
Ask	Introduction	Teacher explain the meaning of the acronym IUPAC "International Union of Pure and Applied Chemistry" as a system of naming Organic compounds	Students ask on how to name Organic Compounds
Investigate	Rules in naming Organic compounds	Teacher identify the rules necessary in naming the Organic compounds: the IUPAC naming system incorporates the root of the name which appears in the middle, the suffix which appears at the end and the prefix which appears at the start. The three parts of the name are linked together as shown below: PREFIX---ROOT---SUFFIX The Root tells us the number of carbon atoms contained in the longest carbon chain in a molecule (Chain Designation: meth-, eth-, prop- & but- for 1, 2, 3 & 4 carbon atoms respectively), the Suffix tells us the class of compound to which the substance belong (Suffix -ane for Alkane, -ene for Alkene, -yne for Alkyne) and the Prefix gives information on the other atoms ogroup of other atoms attached to the main carbon chain (Prepix di- for 2, tri- for 3 and tetra- for 4 number of attached groups).	Students listen to the teacher while explaining the rules of IUPAC nomenclature
Create	Activity showing how to name Organic compounds	Teacher make a demonstration on how to name some Organic compounds: for the structure	Students listen to their teacher and ask questions where necessary while

		below, the name can be seen as follows $CH_3CH_2CH_2CH_3$ There are four carbon atoms in the long chain (but-), the main carbon chain contains only single bond (alkane) and no group is attached. The name is **Butane**	naming the organic compounds
Discuss	Examples and IUPAC names of Organic compounds	Teacher gives some examples of organic compounds and ask the students to provide their IUPAC names	Students work together in order to find the names of the organic compounds by sharing their ideas and experiences
Reflect	Draw the Displayed formula of some Organic compounds	Teacher gives a summary of the whole process on how to name the organic compounds: 1. Count the longest continuous carbon chain 2. List the attached groups 3. Number the carbon to which the branched group is attached and finally Identify if there is any double or triple bond in the structure	Students copy notes and ask questions in areas where they encounter difficulty

Evaluation: Teacher evaluates the students by asking these questions:

1. What IUPAC stand for?
2. Give two examples of organic compounds with their IUPAC names
3. What are the rules in naming organic compounds?

Lesson Three

Subject: Chemistry

Topic: Hydrocarbons

Sub-Topic: Alkanes

Class: SS II

Date: 8/10/2018

Average Age: 16+

Duration: 40 minutes

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

1. State the general formula of Alkane
2. Give examples of Alkane
3. Draw the structure of Alkanes (Methane to Butane)
4. Give the IUPAC Names of the structures
5. Give the properties of Alkanes

Instructional materials: Charts showing the family members of Alkanes, showing their structures, properties and IUPAC names

Entry behavior: Teacher revised about the previous lesson in order to link it with the new lesson

Step	Content	Teachers' Activity	Students' Activity
Ask	Introduction	Teacher explains that all the successive member of Alkane family have a general formula of C_nH_{2n+2}	Students listen to the teacher and ask question on how to apply the general formula
Investigate	General formula of Alkanes	Teacher demonstrates how to use the general formula to identify whether a given compound is a successive member of an Alkane family	Students listen and watch the teacher while demonstration
Create	Examples of Alkane family	Teacher lists some examples of Alkanes starting from Methane, Ethane, Propane then Butane	Students should respond to the question when asked
Discuss	Structure and IUPAC names of Alkanes	Teacher should draw the structure of Methane, Ethane, Propane and Butane showing that each member differ in their structural arrangement by $-CH_2$	Students pay attention to the lesson
Reflect	General Properties of Alkanes	Teacher states the properties of Alkanes, stating that the main feature which differentiate Alkanes from other homologue is that Alkanes are the only saturated hydrocarbons possessing of single bonds in their structures	Students pay attention and ask questions

Evaluation: In order to ascertain the level of students' understanding, the teacher asks the following questions

1. What is the formula of Alkanes?
2. Draw the structure of Methane
3. Mention one property of Alkanes
4. Give two examples of Alkanes

Lesson Four

Subject: Chemistry

Topic: Hydrocarbons

Sub-Topic: Alkenes

Class: SS II

Date: 15/10/2018

Average Age: 16+

Duration: 40 minutes

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

1. Write the general formula of Alkenes
2. Differentiate between Alkenes and Alkanes
3. Give examples of Alkene family
4. Draw their structures and Give their IUPAC Names
5. Give the properties of Alkenes

Instructional materials: Charts containing an examples of Alkenes showing their structural arrangement

Entry behavior: Teacher recalls the previous lesson of Alkanes, their property, structure and IUPAC names

Step	Content	Teachers' Activity	Students' Activity
Ask	Introduction	Teacher explains that all the successive member of Alkene family have a general formula of C_nH_{2n}	Students listen to the teacher, ask question on how to use the general formula
Investigate	General formula of Alkenes	Teacher demonstrates how to use the general formula to identify whether a given compound is a successive homologue of an Alkene	Students listen and watch the teacher while demonstration
Create	Example of Alkenes	Teacher gives examples of Alkenes: Ethene, Propene, Butene, Pentene	Students should respond to the question when asked
Discuss	Structure and IUPAC names of Alkenes	Teacher draws the structure of Ethene, Propene, Butene and Pentene showing that each member differ in their structural form by $–CH_2$ but with the	Students pays attention to the lesson

		possession of at least one double bond in the structure	
Reflect	General Properties of Alkenes	Teacher gives the properties of Alkenes. The main feature which differentiate Alkenes from other homologue is the possession of carbon-carbon double bond (unsaturated) hydrocarbon	Students pay attention and ask questions

Evaluation: The lesson could be evaluated by asking these questions:

1. What is the main feature that differentiate Alkenes from other hydrocarbons?
2. State the general formula of Alkenes
3. Give two examples of Alkenes
4. List one property of Alkenes

Lesson Five

Subject: Chemistry

Topic: Hydrocarbons

Sub-Topic: Alkynes

Class: SS II

Date: 22/10/2018

Average Age: 16+

Duration: 40 minutes

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

1. Give the general formula of Alkynes
2. Differentiate between Alkynes and other Homologous
3. Write some examples of Alkynes
4. Draw their structures and give their IUPAC Names
5. State the properties of Alkynes

Instructional materials: Charts containing an examples of Alkynes showing their structural arrangement

Entry behavior: Teacher recalls the previous lesson of Alkenes, their property, structure and IUPAC names

Step	Content	Teachers' Activity	Students' Activity

Ask	Introduction	Teacher explains that all the successive member of Alkyne family have a general formula of C_nH_{2n-2}	Students listen to the teacher and ask question on how to apply the general formula
Investigate	General formula of Alkynes	Teacher demonstrates how to use the general formula to identify whether a given compound is a successive homologue of an Alkyne	Students listen and watch the teacher while demonstration
Create	Example of Alkynes	Teacher gives examples of Alkynes: Ethyne, Propyne, Butyne, Pentyne	Students should respond to the question when asked
Discuss	Structure and IUPAC names of Alkynes	Teacher draws the structure of Ethyne, Propyne, Butyne and Pentyne showing that each member differ in their structural form by $-CH_2$ with the possession of at least one triple bond in their structure	Students pay attention to the lesson
Reflect	General Properties of Alkynes	Teacher gives the properties of Alkynes. The main feature which differentiate Alkynes from other homologue is the possession of carbon-carbon triple bond (unsaturated) hydrocarbon	Students pay attention and ask questions

Evaluation: Teacher evaluate the lesson by asking the following questions:

1. What is the main feature that differentiate Alkynes from other hydrocarbons?
2. State the general formula of Alkynes
3. Give two examples of Alkynes
4. List one property of Alkynes

Lesson Six

Subject: Chemistry

Topic: Hydrocarbons

Sub-Topic: Isomerism

Class: SS II

Date: 29/10/2018

Average Age: 16+

Duration: 40 minutes

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

1. Explain the term isomerism
2. Define Isomers
3. Give some examples of Isomers
4. Draw the structures of Isomers
5. Give the IUPAC Names of the Isomers

Instructional materials: Charts showing the structures of different Isomers with their IUPAC nomenclature

Entry behavior: Recall the previous lesson of IUPAC nomenclature

Step	Content	Teachers' Activity	Students' Activity
Ask	Introduction	Teacher explains the meaning of isomerism	Students listen and pay attention to the teacher
Investigate	Concept of Isomers	State the meaning of isomers as an organic compounds having the same molecular formula but different structural form and give some examples of isomers	Students respond to the questions when asked
Create	Activity to demonstrate different Isomers	Teacher carry out an activity to demonstrate the phenomena of different Isomers. Example Butane has an isomer of 2-methyl propane	Students listen, watch and ask question where necessary
Discuss	Drawing the structure of Isomers	Teacher draws the structures of some isomers with their IUPAC names	Students draw at least one structure of an isomer
Reflect	General Features of Isomers	Teacher explains the characteristic features of an isomers	Students ask questions where they do not understand

Evaluation: Teacher evaluate the lesson by asking the following questions:

1. Define Isomerism
2. What are Isomers?
3. Give example of an Isomers
4. Draw the structure and give the IUPAC names of the above example

Appendix III

Lesson Plan for Control Group

Lesson One

Subject: Chemistry

Topic: Organic Chemistry

Sub-Topic: Hydrocarbons

Class: SS II

Date: 27/09/2018

Average Age: 16+

Duration: 40 minutes

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

1. Define Organic Chemistry
2. State the Valency of Carbon atom
3. Define the term Hydrocarbon

Entry Behaviour: Recalling the physical characteristics of Organic Compounds, eliciting that they are Compounds formed by sharing of electron(s) between each atom in a covalent bond.

Lesson Presentation:

Step i: The teacher defines the terms Organic Chemistry and Hydrocarbons and state the valency of Carbon atom.

Step ii: The teacher presents to the students a chart and model of Hydrocarbons showing the bonds between Carbon and Hydrogen atoms.

Step iii: The teacher demonstrate how to make a bond between atoms using ball and stick.

Evaluation: By the end of the lesson, teacher evaluates the students by asking these questions:

1. What are Hydrocarbons?
2. Define Organic compounds
3. What is the valency of Carbon atom?

Lesson Two

Subject: Chemistry

Topic: Hydrocarbons

Sub-Topic: IUPAC Nomenclature

Class: SS II

Date: 4/10/2018

Average Age: 16+

Duration: 40 minutes

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

1. State the meaning of the acronym IUPAC
2. Give the IUPAC rules for naming organic compounds
3. Show how to name some organic compounds
4. Give some examples of organic compounds and name them

Instructional Materials: A chart of Organic compounds showing structures with their IUPAC nomenclature

Entry behavior: Review of the previous lesson, that organic compounds are formed by sharing of electrons through covalent bond.

Lesson Presentation: The teacher presents the lesson in the following steps

Step i: Teacher states the meaning of the acronym IUPAC as "International Union of Pure and Applied Chemistry" is a systematic way of naming Organic Compounds.

Step ii: Teacher mention and explain the rules in naming Organic Compounds.

Step iii: The teacher shows how to name some Organic Compounds with examples.

Evaluation: Teacher evaluates the students by asking these questions:

1. What IUPAC stand for?
2. Give two examples of organic compounds with their IUPAC names
3. What are the rules in naming organic compounds?

Lesson Three

Subject: Chemistry

Topic: Hydrocarbons

Sub-Topic: Alkanes

Class: SS II

Date: 11/10/2018

Average Age: 16+

Duration: 40 minutes

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

1. State the general formula of Alkane
2. Give examples of Alkane
3. Draw the structure of Alkanes (Methane to Butane) and give their IUPAC Names.
4. Give the main property of Alkanes

Instructional Materials: Charts showing the family members of Alkanes, showing their structures, properties and IUPAC names.

Entry behavior: Teacher revised about the previous lesson in order to link it with the new lesson

Lesson Presentation

Step i: Teacher gives the general formula of Alkanes as $C_nH_{2n+}2$

Step ii: Teacher show how to use the formula in order to identify a member of Alkane family.

Step iii: Teacher lists some examples of Alkanes with their structures.

Step iv: Teacher states that Alkanes are the only saturated Hydrocarbons with single bonds in their structures.

Evaluation: In order to ascertain the level of students' understanding, the teacher asks the following questions

1. What is the general formula of Alkanes?
2. Draw the structure of Methane
3. Mention one property of Alkanes
4. Give two examples of Alkanes

Lesson Four

Subject: Chemistry

Topic: Hydrocarbons

Sub-Topic: Alkenes

Class: SS II

Date: 18/10/2018

Average Age: 16+

Duration: 40 minutes

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

1. Write the general formula of Alkenes
2. Differentiate between Alkenes and Alkanes
3. Give examples of Alkenes with their structures and IUPAC Names
4. Give the main property of Alkenes

Instructional materials: Charts containing an examples of Alkenes showing their structural arrangement.

Entry behavior: Teacher recalls the previous lesson of Alkanes, their property, structure and IUPAC nomenclature.

Lesson Presentation:

Step i: Teacher gives the general formula of Alkenes as C_nH_{2n}

Step ii: The teacher shows how to identify a given compound of Alkene using the formula.

Step iii: Teacher gives some examples of Alkenes with their structures and IUPAC names

Step iv: Teacher identify the main property that distinguish Alkenes from other Hydrocarbons by possessing a double bond in their structures.

Evaluation: The lesson could be evaluated by asking these questions:

1. What is the main feature that differentiate Alkenes from other hydrocarbons?
2. State the general formula of Alkenes
3. Give two examples of Alkenes

Lesson Five

Subject: Chemistry

Topic: Hydrocarbons

Sub-Topic: Alkynes

Class: SS II

Date: 25/10/2018

Average Age: 16+

Duration: 40 minutes

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

1. Give the general formula of Alkynes
2. Differentiate between Alkynes and other Homologous
3. Write some examples of Alkynes
4. Draw their structures and give their IUPAC Names
5. State the properties of Alkynes

Instructional materials: Charts containing an examples of Alkynes showing their structural arrangement

Entry behavior: Teacher recalls the previous lesson of Alkenes, their property, structure and IUPAC nomenclature

Lesson Presentation:

Step i: Teacher gives the general formula of Alkynes as C_nH_{2n-2}

Step ii: Demonstrate how to find a member of Alkynes using the formula

Step iii: Gives some examples of the members of Alkynes with their structures and IUPAC names

Step iv: Give one physical feature that differentiate Alkynes from other Hydrocarbons by having at least one triple bond in their structures

Evaluation: Teacher evaluates the lesson by asking questions like:

1. What is the main feature that differentiate Alkynes from other hydrocarbons?
2. State the general formula of Alkynes
3. Give two examples of Alkynes

Lesson Six

Subject: Chemistry

Topic: Hydrocarbons

Sub-Topic: Isomerism

Class: SS II

Date: 1/11/2018

Average Age: 16+

Duration: 40 minutes

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

1. Explain the term isomerism
2. Define Isomers
3. Give some examples of Isomers
4. Draw the structures of Isomers and give the IUPAC Names of the Isomers

Instructional materials: Charts showing the structures of different Isomers with their IUPAC nomenclature

Entry behavior: Recall the previous lesson of IUPAC nomenclature

Lesson Presentation

Step i: Teacher explains the meaning of isomerism

Step ii: State the meaning of isomers as Organic compounds having the same molecular formula but different structural arrangement.

Step iii: Give example of an isomers like Butane has an isomer of 2-methyl propane

Step iv: Draw the structures of the isomers above and give their IUPAC names

Evaluation: Teacher evaluates the lesson by asking the following questions:

1. Define Isomerism
2. What are Isomers?
3. Give example of an Isomers
4. Draw the structure and give the IUPAC names of the above example

Appendix IV

PRE-VALIDATED ORGANIC CHEMISTRY ACHIEVEMENT TEST (OCAT) & STUDENTS' MOTIVATION RATING SCALE (SMRS)

SECTION A: Personal Data

Name of School: _____

Class:_____

Sex: Male [ ] Female [ ] Time Allowed: 1 hour

SECTION B: Instructions: Answer all questions by ticking the correct options from lettered A-D.

1. _____Is the study of compounds of carbon.

   (A) Hydrocarbon (B) Organic Chemistry (C) Inorganic Chemistry (D) Chemistry

2. All alkane has the general formula as _____

   (A) $C_nH_{2n}OH$ (B) C_nH_{2n-2} (C) C_nH_{2n+2} (D) C_nH_{2n}

3. The IUPAC name of C_4H_8 is

   (A) Butene (B) Propane (C) Butanol (D) Hexane

4. Organic compounds consisting elements of carbon and hydrogen only are called_____

   (A) Hydrocarbons (B) Halogens (c) Homologous (D) Halogenoalkanes

5. Compounds possessing only single bonds in there structures are called _____ Compounds.

   (A) Aliphatic (B) Unsaturated (C) Cyclic (D) Saturated

6. Isomerism is the existence of different compounds with the same molecular formula but different _____

   (A) Structural formula (B) Carbon atom (C) Isotopes (D) Nomenclature

7. Which homologous series is a saturated hydrocarbon?

   (A) Alkenes (B) Alcohol (C) Alkanes (D) Alkynes

8. All alkynes has the general formula of_____

   (A) C_nH_{2n-2} (B) C_nH_{2n} (C) C_nH_{2n+2} (D) R-COOH

9. Compounds with the same molecular formula but different structural arrangement are called _____

(A) Homologous (B) Isomers (C) Esters (D) Isomerism

10. Hydrocarbons with only single covalent bonds in their structures are known as

    (A) Alkanes (B) Alkenes (C) Alkynes (D) Aldehydes

11. Butane is an Alkane with _____ atoms.

    (A) 2 Carbon (B) 3 Carbon (C) 4 Carbon (D) 5 Carbon

12. Alkene is a hydrocarbon with

    (A) One triple bond (B) One double bond (C) All single bonds (D) All double bonds

13. An isomer of C_5H_{12} is

    (A) 2-methyl ethane (B) 2-methyl propane (C) 2-methyl butane (D) 2,2-dimethyl pentane

14. Ethene undergoes mainly addition reactions because it is

    (A) Polymerized (B) Hydrocarbon (C) Alkane (D) Unsaturated

15. _____is an element that have the ability to catenate.

    (A) Carbon (B) Nitrogen (C) Chlorine (D) Hydrogen

16. To which homologous series does C4H6 belong?

    (A) Aromatic (B)Alkenes (C) Alkanes (D) Alkynes

17. Alkane family can undergo…… reaction

    (A) Addition (B) Substitution (C) Elimination (D) Condensation

18. What is the main source of hydrocarbons?

(A) Petrol (B) Crude oil (C) Paraffin (D) Diesel

19. The naming system of Organic Compounds is called

(A) IUPAC Nomenclature (B) Systematic Nomenclature (C) Trivial Naming (D) Source

20. Alkanes react mainly with halogens by _____

(A) Oxidation (B) Reduction (C) Substitution (D) Addition

21. Which of these compounds belong to the same homologous series

(A) C_3H_8 & C_3H_6 (B) C_2H_4 & C_4H_{10} (C) C_2H_6 & C_4H_{10} (D) C_2H_2 & CH_4

22. Alkenes are another homologous series with a general formula

(A) C_nH_{2n} (B) C_nH_n (C) $C_nH_{2n}OH$ (D) C_nH_{2n-2}

23. What does X represent in the following equation

$$\mathbf{X_{(g)} + 3O_{2(g)} \longrightarrow 2H_2O_{(l)} + 2CO_{2(g)}}$$

(A)CH_4 (B) C_2H_2 (C) CO (D) C_2H_4

24. The reaction between C_2H_2 and HBr is called _____

(A) Substitution (B) Addition (C) Oxidation (D) Elimination

25. What is the main type of reaction Alkenes undergo?

(A) Condensation (B) substitution (C) Oxidation (D) Addition

26. The main feature that distinguishes Alkene from Alkane is

(A) C----C (B) C----OH (C) C==C (D) C==O

27. Hydrocarbons are generally classified into

(A) Aliphatic & Aromatic (B) Acyclic & Ring (C) Ring & Branch (D) Cyclic & Ring

28. Organic Compounds with six-membered rings of carbon atoms are _____compounds

(A) Straight Chain (B) Aliphatic (C) Aromatic (D) Cyclic

29. The two Unsaturated Homologous of Hydrocarbons are _____

(A) Alkanes&Alkenes(B)Alkenes&Alkynes(C)Alkynes&Alkanes(D)Aromatic&Aliphatic

30. Organic Compounds that have a chain of carbon atoms in their structures are called_____

(A) Cyclic compounds (B) Aromatic compounds (C) Ring Compounds (D) Aliphatic compounds

STUDENTS' MOTIVATION RATING SCALE (SMRS)

Key:
Strongly Agree = 4
Agree = 3
Disagree = 2
Strongly disagree = 1

S/N	**ITEMS**	4	3	2	1
1.	I study hard to learn Organic Chemistry				
2.	I am sure I can understand Organic Chemistry				
3.	My career will involve Organic Chemistry				
4.	Learning Organic Chemistry makes my life more meaningful				
5.	I think about the grade I will get in Organic Chemistry				
6.	I spend a lot of time learning Organic Chemistry				
7.	I find learning Organic Chemistry interesting				
8.	I enjoy learning Organic Chemistry				
9.	I am confident that I will do well in Organic Chemistry test				
10.	Learning Organic Chemistry will help me get a good job				
11.	The Organic Chemistry I learn is relevant to my life				
12.	I use strategies to learn Organic Chemistry well				
13.	Understanding Organic Chemistry will benefit me in my career				
14.	I like to do better than other students in Organic Chemistry test				
15.	I prepare well for Organic Chemistry test				
16.	Scoring high in Organic Chemistry tests matters to me				
17.	I believe I can master Organic Chemistry knowledge and skills				
18.	I like Organic Chemistry that is challenging me				
19.	I am curious about discoveries in Organic Chemistry				
20.	It is important to get "A" grade in Organic Chemistry				

Appendix V

VALIDATED ORGANIC CHEMISTRY ACHIEVEMENT TEST (OCAT) & STUDENTS' MOTIVATION RATING SCALE (SMRS)

PRE TEST

SECTION A: Personal Data

Name of School: _____

Sex: Male [ ] Female [ ] Time Allowed: 1 hour

SECTION B: STUDENTS' ACHIEVEMENT IN CHEMISTRY

Instructions: Answer all questions by ticking the correct options from lettered A-D.

1. _____Is the study of compounds of carbon?

   (A) Hydrocarbon (B) Organic Chemistry (C) Inorganic Chemistry (D) Chemistry

2. All alkane has the general formula as _____?

   (A) $C_nH_{2n}OH$ (B) C_nH_{2n-2} (C) C_nH_{2n+2} (D) C_nH_{2n}

3. The IUPAC name of C_4H_8 is_____?

   (A) Butene (B) Propane (C) Butanol (D) Hexane

4. Organic compounds consisting elements of carbon and hydrogen only are called_____?

   (A) Hydrocarbons (B) Halogens (c) Homologous (D) Halogenoalkanes

5. Compounds possessing only single bonds in there structures are called _____ Compounds?

   (A) Aliphatic (B) Unsaturated (C) Cyclic (D) Saturated

6. Isomerism is the existence of different compounds with the same molecular formula but different _____?

   (B) Structural formula (B) Carbon atom (C) Isotopes (D) Nomenclature

7. Which homologous series is a saturated hydrocarbon?

   (A) Alkenes (B) Alcohol (C) Alkanes (D) Alkynes

8. All alkynes has the general formula of_____?

   (A) C_nH_{2n-2} (B) C_nH_{2n} (C) C_nH_{2n+2} (D) R-COOH

9. Compounds with the same molecular formula but different structural arrangement are called _____?

   (A) Homologous (B) Isomers (C) Esters (D) Isomerism

10. Hydrocarbons with only single covalent bonds in their structures are known as_____?

    (A) Alkanes (B) Alkenes (C) Alkynes (D) Aldehydes

11. Butane is an Alkane with _____ atoms?

    (A) 2 Carbon (B) 3 Carbon (C) 4 Carbon (D) 5 Carbon

12. Alkene is a hydrocarbon with_____?

    (A) One triple bond (B) One double bond (C) All single bonds (D) All double bonds

13. An isomer of C_5H_{12} is_____?

    (A) 2-methyl ethane (B) 2-methyl propane (C) 2-methyl butane (D) 2,2-dimethyl pentane

14. Ethene undergoes mainly addition reactions because it is_____?

    (A) Polymerized (B) Hydrocarbon (C) Alkane (D) Unsaturated

15. _____is an element that have the ability to catenate?

    (A) Carbon (B) Nitrogen (C) Chlorine (D) Hydrogen

16. To which homologous series does C4H6 belong?

    (B) Aromatic (B)Alkenes (C) Alkanes (D) Alkynes

17. Alkane family can undergo…… reaction?

(B) Addition (B) Substitution (C) Elimination (D) Condensation

18. What is the main source of hydrocarbons?

(A) Petrol (B) Crude oil (C) Paraffin (D) Diesel

19. The naming system of Organic Compounds is called_____?

(B) IUPAC Nomenclature (B) Systematic Nomenclature (C) Trivial Naming (D) Source

20. Alkanes react mainly with halogens by _____?

(A) Oxidation (B) Reduction (C) Substitution (D) Addition

21. Which of these compounds belong to the same homologous series?

(A) C_3H_8 & C_3H_6 (B) C_2H_4 & C_4H_{10} (C) C_2H_6 & C_4H_{10} (D) C_2H_2 & CH_4

22. Alkenes are another homologous series with a general formula_____?

(A) C_nH_{2n} (B) C_nH_n (C) $C_nH_{2n}OH$ (D) C_nH_{2n-2}

23. What does X represent in the following equation?

$$\mathbf{X_{(g)} + 3O_{2(g)} \longrightarrow 2H_2O_{(l)} + 2CO_{2(g)}}$$

(A)CH_4 (B) C_2H_2 (C) CO (D) C_2H_4

24. The reaction between C_2H_2 and HBr is called _____?

(B) Substitution (B) Addition (C) Oxidation (D) Elimination

25. What is the main type of reaction Alkenes undergo?

(A) Condensation (B) substitution (C) Oxidation (D) Addition

26. The main feature that distinguishes Alkene from Alkane is _____?

(A) C----C (B) C----OH (C) C==C (D) C==O

27. Hydrocarbons are generally classified into _____?

(B) Aliphatic & Aromatic (B) Acyclic & Ring (C) Ring & Branch (D) Cyclic & Ring

28. Organic Compounds with six-membered rings of carbon atoms are _____compounds?

    (A) Straight Chain (B) Aliphatic (C) Aromatic (D) Cyclic

29. The two Unsaturated Homologous of Hydrocarbons are _____?

    (B) Alkanes&Alkenes(B)Alkenes&Alkynes(C)Alkynes&Alkanes(D)Aromatic&Aliphatic

30. Organic Compounds that have a chain of carbon atoms in their structures are called_____?

(B) Cyclic compounds (B) Aromatic compounds (C) Ring Compounds (D) Aliphatic compounds

SECTION C: STUDENTS' MOTIVATION RATING SCALE (SMRS)

Instruction: Select by ticking the appropriate option based on your opinion.

Key:

Strongly Agree = 4
Agree = 3
Disagree = 2
Strongly disagree = 1

S/N	ITEMS	4	3	2	1
1.	I study hard to learn Organic Chemistry				
2.	I am sure I can understand Organic Chemistry				
3.	I study Organic Chemistry because I want to make it my career				
4.	Learning Organic Chemistry makes my life more meaningful				
5.	I think about the grade I will get in Organic Chemistry				
6.	I spend a lot of time learning Organic Chemistry				
7.	I find learning Organic Chemistry very interesting				
8.	I enjoy learning Organic Chemistry				
9.	I am confident that I will do well in Organic Chemistry test				
10.	Learning Organic Chemistry will help me get a good job				
11.	I study Organic Chemistry because it is relevant to my life				
12.	I use different strategies to learn Organic Chemistry well				
13.	Understanding Organic Chemistry will benefit me in my career				
14.	I like to do better than other students in Organic Chemistry test				
15.	I prepare well for Organic Chemistry test				
16.	Scoring high in Organic Chemistry tests matters to me				
17.	I believe I can master Organic Chemistry knowledge and skills				
18.	Organic Chemistry which is challenging encourage me more				
19.	I am curious about discoveries in Organic Chemistry hence reason for my good performance in it				
20.	It is important to get "A" grade in Organic Chemistry in order to study further				

Appendix VI

ORGANIC CHEMISTRY ACHIEVEMENT TEST (OCAT) & STUDENTS' MOTIVATION RATING SCALE (SMRS)

POST TEST

SECTION A: Personal Data

Name of School: _____

Sex: Male [ ] Female [ ] Time Allowed: 1 hour

SECTION B: STUDENTS' ACHIEVEMENT IN CHEMISTRY

Instructions: Answer all questions by ticking the correct options from lettered A-D.

1. _____Is the study of compounds of carbon?

   (A) Hydrocarbon (B) Organic Chemistry (C) Inorganic Chemistry (D) Chemistry

2. All alkane has the general formula as _____?

   (A) $C_nH_{2n}OH$ (B) C_nH_{2n-2} (C) C_nH_{2n+2} (D) C_nH_{2n}

3. The IUPAC name of C_4H_8 is_____?

   (A) Butene (B) Propane (C) Butanol (D) Hexane

4. Organic compounds consisting elements of carbon and hydrogen only are called_____?

   (A) Hydrocarbons (B) Halogens (c) Homologous (D) Halogenoalkanes

5. Compounds possessing only single bonds in there structures are called _____ Compounds?

   (A) Aliphatic (B) Unsaturated (C) Cyclic (D) Saturated

6. Isomerism is the existence of different compounds with the same molecular formula but different _____?

   (C) Structural formula (B) Carbon atom (C) Isotopes (D) Nomenclature

7. Which homologous series is a saturated hydrocarbon?

   (A) Alkenes (B) Alcohol (C) Alkanes (D) Alkynes

8. All alkynes has the general formula of_____?

   (A) C_nH_{2n-2} (B) C_nH_{2n} (C) C_nH_{2n+2} (D) R-COOH

9. Compounds with the same molecular formula but different structural arrangement are called _____?

   (A) Homologous (B) Isomers (C) Esters (D) Isomerism

10. Hydrocarbons with only single covalent bonds in their structures are known as_____?

    (A) Alkanes (B) Alkenes (C) Alkynes (D) Aldehydes

11. Butane is an Alkane with _____ atoms?

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12. Alkene is a hydrocarbon with_____?

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13. An isomer of C_5H_{12} is_____?

    (A) 2-methyl ethane (B) 2-methyl propane (C) 2-methyl butane (D) 2,2-dimethyl pentane

14. Ethene undergoes mainly addition reactions because it is_____?

    (A) Polymerized (B) Hydrocarbon (C) Alkane (D) Unsaturated

15. _____is an element that have the ability to catenate?

    (A) Carbon (B) Nitrogen (C) Chlorine (D) Hydrogen

16. To which homologous series does C4H6 belong?

    (C) Aromatic (B)Alkenes (C) Alkanes (D) Alkynes

17. Alkane family can undergo…… reaction?

(C) Addition (B) Substitution (C) Elimination (D) Condensation

18. What is the main source of hydrocarbons?

(A) Petrol (B) Crude oil (C) Paraffin (D) Diesel

19. The naming system of Organic Compounds is called_____?

(C) IUPAC Nomenclature (B) Systematic Nomenclature (C) Trivial Naming (D) Source

20. Alkanes react mainly with halogens by _____?

(A) Oxidation (B) Reduction (C) Substitution (D) Addition

21. Which of these compounds belong to the same homologous series?

(A) C_3H_8 & C_3H_6 (B) C_2H_4 & C_4H_{10} (C) C_2H_6 & C_4H_{10} (D) C_2H_2 & CH_4

22. Alkenes are another homologous series with a general formula_____?

(A) C_nH_{2n} (B) C_nH_n (C) $C_nH_{2n}OH$ (D) C_nH_{2n-2}

23. What does X represent in the following equation?

$$\mathbf{X_{(g)} + 3O_{2(g)} \longrightarrow 2H_2O_{(l)} + 2CO_{2(g)}}$$

(A)CH_4 (B) C_2H_2 (C) CO (D) C_2H_4

24. The reaction between C_2H_2 and HBr is called _____?

(C) Substitution (B) Addition (C) Oxidation (D) Elimination

25. What is the main type of reaction Alkenes undergo?

(A) Condensation (B) substitution (C) Oxidation (D) Addition

26. The main feature that distinguishes Alkene from Alkane is _____?

(A) C----C (B) C----OH (C) C==C (D) C==O

27. Hydrocarbons are generally classified into _____?

(C) Aliphatic & Aromatic (B) Acyclic & Ring (C) Ring & Branch (D) Cyclic & Ring

28. Organic Compounds with six-membered rings of carbon atoms are _____compounds?

    (A) Straight Chain (B) Aliphatic (C) Aromatic (D) Cyclic

29. The two Unsaturated Homologous of Hydrocarbons are _____?

    (C) Alkanes&Alkenes(B)Alkenes&Alkynes(C)Alkynes&Alkanes(D)Aromatic&Aliphatic

30. Organic Compounds that have a chain of carbon atoms in their structures are called_____?

(C) Cyclic compounds (B) Aromatic compounds (C) Ring Compounds (D) Aliphatic compounds

SECTION C: STUDENTS' MOTIVATION RATING SCALE (SMRS)

Instruction: Select by ticking the appropriate option based on your opinion.

Key:

Strongly Agree = 4
Agree = 3
Disagree = 2
Strongly disagree = 1

S/N	ITEMS	4	3	2	1
1.	I study hard to learn Organic Chemistry				
2.	I am sure I can understand Organic Chemistry				
3.	I study Organic Chemistry because I want to make it my career				
4.	Learning Organic Chemistry makes my life more meaningful				
5.	I think about the grade I will get in Organic Chemistry				
6.	I spend a lot of time learning Organic Chemistry				
7.	I find learning Organic Chemistry very interesting				
8.	I enjoy learning Organic Chemistry				
9.	I am confident that I will do well in Organic Chemistry test				
10.	Learning Organic Chemistry will help me get a good job				
11.	I study Organic Chemistry because it is relevant to my life				
12.	I use different strategies to learn Organic Chemistry well				
13.	Understanding Organic Chemistry will benefit me in my career				
14.	I like to do better than other students in Organic Chemistry test				
15.	I prepare well for Organic Chemistry test				
16.	Scoring high in Organic Chemistry tests matters to me				
17.	I believe I can master Organic Chemistry knowledge and skills				
18.	Organic Chemistry which is challenging encourage me more				
19.	I am curious about discoveries in Organic Chemistry hence reason for my good performance in it				
20.	It is important to get "A" grade in Organic Chemistry in order to study further				

Appendix VII

ORGANIC CHEMISTRY ACHIEVEMENT TEST

ANSWER SHEET

Name of School:…….

Students Number:……..

Gender:…… **Time**: 1:00 hour

Select the most appropriate option from the options provided

1. [a] [b] [c] [d]
2. [a] [b] [c] [d]
3. [a] [b] [c] [d]
4. [a] [b] [c] [d]
5. [a] [b] [c] [d]
6. [a] [b] [c] [d]
7. [a] [b] [c] [d]
8. [a] [b] [c] [d]
9. [a] [b] [c] [d]
10. [a] [b] [c] [d]
11. [a] [b] [c] [d]
12. [a] [b] [c] [d]
13. [a] [b] [c] [d]
14. [a] [b] [c] [d]
15. [a] [b] [c] [d]
16. [a] [b] [c] [d]
17. [a] [b] [c] [d]
18. [a] [b] [c] [d]
19. [a] [b] [c] [d]
20. [a] [b] [c] [d]
21. [a] [b] [c] [d]
22. [a] [b] [c] [d]
23. [a] [b] [c] [d]
24. [a] [b] [c] [d]
25. [a] [b] [c] [d]
26. [a] [b] [c] [d]
27. [a] [b] [c] [d]
28. [a] [b] [c] [d]
29. [a] [b] [c] [d]
30. [a] [b] [c] [d]

Appendix VIII

VALIDATION REQUEST LETTER

Department of Science and Technology Education,

Faculty of Education,

Bayero University, Kano.

Date: 16/07/2018

…….

……..

…….

…….

Request for Validation of Organic Chemistry Achievement Test (OCAT) & Students' Motivation Rating Scale (SMRS)

I am a postgraduate student of the above named institution undergoing a study on the Effects of Guided Inquiry on Motivation and Academic Achievement in Organic Chemistry among Secondary School Students in Musawa, Katsina State, Nigeria. I solicit for your assistance in validating my research instruments as your professional correction and modification will help to authenticate the instruments.

Attached are copies of Objectives of the study, Research Questions, Research Hypothesis and the topic to be covered for the study, Terms of Reference of Validation, Organic Chemistry Achievement Test (OCAT), Students Motivation Rating Scale (SMRS) and Marking Scheme for (OCAT).

Yours faithfully

Muhammad Hamza

Appendix IX

VALIDATORS COMMENT ON ORGANIC CHEMISTRY ACHIEVEMENT TEST (OCAT)

ITEM NO.	FIRST VALIDATOR	SECOND VALIDATOR	THIRD VALIDATOR	ACTION TAKING
All items	Reshuffle		Reshuffle	Reshuffled
2	Reframe	Restructure		Corrected
4		Reframe	Reframe	Reframed
5	Reframe	_____	Restructure	Corrected
6		_____	Reframe	Corrected
9	Recast	Recast	_____	Recast
16	_____	_____	Reframe	Reframed
28			Reframe	Reframed

VALIDATORS COMMENT ON STUDENTS' MOTIVATION RATING SCALE (SMRS)

ITEM NO.	FIRST VALIDATOR	SECOND VALIDATOR	THIRD VALIDATOR	ACTION TAKING
All items	Reshuffle		Reshuffle	Reshuffled
3	Recast			Recast
11	Recast			Recast
12	Reframe	_____		Reframe
18	Recast	_____		Recast
19	Recast		_____	Recast
20	Restructure		_____	Restructured

Appendix X

ANALYSIS OF PILOT TEST RESULT (RELIABILITY)

```
CORRELATIONS
  /VARIABLES=TEST RETEST
  /PRINT=TWOTAIL NOSIG
  /MISSING=PAIRWISE.
```

Correlations

Correlations

		TEST	RETEST
TEST	Pearson Correlation	1	.841**
	Sig. (2-tailed)		.002
	N	10	10
RETEST	Pearson Correlation	.841**	1
	Sig. (2-tailed)	.002	
	N	10	10

**. Correlation is significant at the 0.01 level (2-tailed).

Cronbach's Alpha	Part 1	Value	1.000
		N of Items	1[a]
	Part 2	Value	1.000
		N of Items	1[b]
		Total N of Items	2
Correlation Between Forms			.589
Spearman-Brown		Equal Length	.742
Coefficient		Unequal Length	.742
Guttman Split-Half Coefficient			.713

a. The items are: ODD
b. The items are: EVEN

Appendix XI

Item analysis

Items	Actual scores	Difficulty Index		Item Ranking	Discrimination Index
1	3	.3	Upper G. (6)	5	
2	3	.3		4	
3	3	.3		4	
4	4	.4		4	
5	3	.3		4	
6	3	.3		4	
7	3	.3		3	
8	4	.4	Middle G.	3	
9	3	.3		3	
10	3	.3		3	
11	3	.3		3	
12	3	.3		3	
13	4	.4		3	
14	3	.3		3	
15	5	.5		3	
16	3	.3		3	
17	3	.3		3	
18	3	.3		3	
19	3	.3		3	
20	3	.3		3	
21	3	.3		3	
22	4	.4		3	
23	3	.3		3	
24	3	.3	Lower G. (7)	3	
25	3	.3		3	
26	3	.3		3	
27	4	.4		3	
28	3	.3		3	
29	3	.3		3	
30	3	.3		3	

Appendix XII

SPSS VERSION 20 RESULT OF DESCRIPTIVE STATISTICS AND Z-Test TABLE

ANALYSIS OF THE POST TEST RESULT OF EXPERIMENTAL AND CONTROL GROUPS

```
Z-TEST GROUPS=Groups (1 2)
  /MISSING=ANALYSIS
  /VARIABLES=Posttest
  /CRITERIA=CI (.95).
```

Group Statistics

	Groups	N	Mean	Std. Deviation	Std. Error Mean
Posttest	Experimental	35	21.4571	2.71535	.45898
	Control	37	14.1081	2.97007	.48828

Independent Samples Test

		Levene's Test for Equality of Variances		Z-test for Equality of Means						
		F	Sig.	Z	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Posttest	Equal variances assumed	.015	.902	10.939	70	.000	7.34903	.67182	6.00913	8.68894
	Equal variances not assumed			10.967	69.923	.000	7.34903	.67013	6.01248	8.68559

Appendix XIII

ANALYSIS OF POST TEST RESULT OF MALE AND FEMALE STUDENTS OF THE EXPERIMENTAL GROUP

```
DATASET ACTIVATE DataSet1.
Z-TEST GROUPS=Gender (1 2)
  /MISSING=ANALYSIS
  /VARIABLES=Posttest
  /CRITERIA=CI (.95).
```

Z-Test

Group Statistics

	Groups	N	Mean	Std. Deviation	Std. Error Mean
Posttest	Male	20	21.5500	2.87411	.64267
	Female	15	21.3333	2.58199	.66667

Independent Samples Test

		Levene's Test for Equality of Variances		Z-test for Equality of Means						
		F	Sig.	Z	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Posttest	Equal variances assumed	.259	.614	.230	33	.819	.21667	.94066	-1.69712	2.13045
	Equal variances not assumed			.234	31.846	.816	.21667	.92600	-1.66989	2.10322

Appendix XIV

ANALYSIS OF THE POST TEST AND PRETEST RESULT OF EXPERIMENTAL GROUP

```
U-TEST GROUPS=Groups (1 2)
   /VARIABLES=Posttest & Pretest
  /CRITERIA=CI (.95).
```

U-Test

Descriptive Statistics

	Groups	N	Mean	Std. Deviation	Minimum	Maximum
	Posttest	35	47.7429	14.57980	23.00	73.00
	Pretest	35	1.50000	.50361	1.00	2.00

Mann-Whitney Test

Test	N	Mean Rank	Sum of Ranks
Post Test	35	52.60	1841.00
Pre Test	35	18.40	644.00
Total	70		

Test Statistics

	MScale Score
Mann-Whitney U	14.00
Wilcoxon W	644.000
Z	-7.034
Asymp. Sig. (2tailed)	.000

a. Grouping Variable: test

Appendix XV

ANALYSIS OF POST TEST RESULT OF MALE AND FEMALE STUDENTS OF THE EXPERIMENTAL GROUP

U-TEST GROUPS=Gender (1 2)
/VARIABLES=Posttest
/CRITERIA=CI (.95).

Descriptive Statistics

	Groups	N	Mean	Std. Deviation	Minimum	Maximum
Posttest	Male	20	60.2286	7.75388	46.00	73.00
	Female	15	1.4289	.50210	1.00	2.00

Mann-Whitney Test

Gender	N	Mean Rank	Sum
Male	20	17.03	340.50
Female	15	19.30	289.50
Total	35		

Test Statistics

	MScale Score Experimental
Mann-Whitney U	130.500
Wilcoxon W	340.500
Z	-.651
Asymp. Sig. (2-tailed)	.515
Exact Sig. [2*(1-tailed Sig.)]	.521[b]

a. Grouping Variable: Gender
b. Not corrected for ties.