EFFECTS OF DEMONSTRATION TEACHING STRATEGY IN REMEDYING MISCONCEPTIONS IN ORGANIC CHEMISTRY AMONG STUDENTS OF COLLEGES OF EDUCATION IN KANO STATE

BY

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M.ED THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL AHMADU BELLO UNIVERSITY, ZARIA, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTERS IN SCIENCE EDUCATION

DEPARTMENT OF EDUCATION
AHMADU BELLO UNIVERSITY
ZARIA – NIGERIA

JUNE, 2011

DECLARATION

I hereby declare that this thesis titled "Effects of Demonstration Teaching Strategy in Remedying Misconceptions in Organic Chemistry Among Students of Colleges of Education in Kano State" has been written by me. It is a record of my own research work and it has not been presented in any previous work before for a higher degree or published in a book. All quotations and sources of information are acknowledged by means of references.

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Adamu Idris Maizuwo Date

CERTIFICATION

This thesis, titled “Effects of Demonstration Teaching Strategy in Remedying Misconceptions in Organic Chemistry among Students of Colleges of Education in Kano State” by Adamu Idris Maizuwo meets the regulations governing the award of the degree of Masters in Science Education of Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This work is dedicated to my mother; Hauwa'u Abubakar and my junior brother, Mahmud Idris Abdullahi.

ACKNOWLEDGEMENT

I thank and praise Allah for giving me all I need to complete this thesis successfully.

I wish to state and place on record the invaluable contribution of Dr. (Mrs.) S. B. Olorukooba, my major supervisor for her guidance, constructive criticisms, and encouragement that saw this work through. I wish her Allah's guidance and protection.

Much gratitude and prayers to Dr. S. S. Bichi, my minor supervisor for his fatherly advice, guidance and word of encouragement throughout the duration of my work. May Allah protect and keep him on the right path.

I am very grateful to Dr. Alhaji Isah Usman for his wonderful advice, contributions and encouragement. May Allah accept your prayers and reward you abundantly. Ameen. Furthermore, I wish to express my sincere gratitude to the following lecturers for their contribution during my proposal defense; Dr. (Mrs.) T. E. Lawal; Dr. (Mrs.) J. O. Olajide; Dr. (Mrs.) M. A. Lakpini; Hajiya F. K. Lawal and Dr. (Mrs.) E. P. Adeniyi.

I am also grateful to all my lecturers in of science education section whose names are not mentioned above for their involvement, contributions and encouragement, in one way or the other, towards the completion of this work.

I am particularly indebted to my aged mother, my wife and children, for their contributions, tolerance, patience and prayers, throughout the period of my study. I am also indebted to my colleagues in the university, such as, Hussain Yahaya Peni, Yahaya Isah Bunkure, Hajiya Binta Shika, Dayyabu D/waire etc. and all my course mates.

My special thanks go to my colleagues in Sa'adatu Rimi College of Education, Federal College of Education Kano and Federal College of Education (Tech.) Bichi, as well as all others too numerous to mention here, for their contributions to the successful completion of this work.

ABSTRACT

This study investigated the effectiveness of demonstration teaching strategy on students' misconceptions of concepts in organic chemistry and academic achievement of NCE II chemistry students in colleges of education in Kano state. The study is of a pre-test post-test quasi experimental control design. One hundred and twenty six NCE II chemistry students from two colleges of education in Kano state were used as the sample of the study. The instruments used for data collection were; Organic Chemistry Achievement Test (OCAT) and Organic Chemistry Misconception Test (OCMT). The two tests were used to determine group equivalence and level of misconception of the students (pre-tests) and also to determine the effectiveness of demonstration method on the misconception of concepts (post-tests). The data analysis was carried out using statistical package for social sciences (SPSS 16) in which the t-test analysis revealed that students taught organic chemistry concepts through demonstration teaching method (experimental group) performed significantly higher than those taught same using lecture method (control group). Thus, demonstration teaching method enhances academic achievement, in addithition to remedying students' misconception in organic chemistry. Among other things, the finding of the study was that demonstration teaching method was gender friendly. The study recommends, among other things that: i) chemistry teachers should be encouraged, motivated and assisted to use demonstration teaching method and Efforts should be geared towards the use of demonstration teaching method in tertiary institutions (NCE level) by the authorities concerned.

ABBREVIATIONS USED

NCE: Nigeria Certificate in Education

OCAT: Organic Chemistry Achievement Test

OCMT: Organic Chemistry Misconception Test

DM: Demonstration Method

LM: Lecture Method

STAN: Science Teachers Association of Nigeria

FME: Federal Ministry of Education

NCCE: National Commission for Colleges of Education

NECO: National Examination Council

OPERATIONAL DEFINITION OF TERMS

1. Misconception: Privately held knowledge of an individual or individuals that departs significantly from the scientifically held version of that knowledge domain and concept.

2. Preconceived notion: A popular notion that is rooted in everyday experiences of the learner about the concepts taught. This can be scientifically wrong or right.

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CHAPTER ONE

THE PROBLEM

1.1 Introduction

In many countries, science and technology education has been identified as the universal foundation for economic growth and stability (Abdullah, 2006). In the past, and in many countries of the world, only exceptionally brilliant students were encouraged to pursue science, because science was viewed as knowledge accessible to only the few elites (Abdullah, 2006). Nowadays, people depend so much on products/outputs of science and technology to meet their daily needs, for example food, shelter, and clothing. It is therefore, logical to say that science is the backbone of developments and that it should be accessible to all. Furthermore, countries that are in forefront in terms of economic development and social welfare schemes rely on science education programme as the bedrock of their development (Iliyasu, 2000).

Scientific discoveries and their applications to industry, communication, agriculture, medicine and warfare have brought great changes in the lives and culture of individuals in various societies. In effect, it is not only raising the standard of living of the people but also it transforms the national economy into a diversified and self-sustained system.

Science uses observation and inference as fundamental tools for inquiry. Science can therefore be defined as knowledge within the limits of perception of individuals (Earl, 2000). Through science, people achieve greater understanding of their environment. Chemistry, as a branch of science is the study of matter and its properties, including the structure, composition and the transformation that it undergoes. Furthermore, Chemistry can be characterized and studied under its varying branches; organic, inorganic, physical, analytical, industrial, nuclear. Chemistry is necessary for the development of natural resources, provision of good health and facilitation of adequate food supply and favorable living environment. For effective application of natural sciences, an understanding of chemistry concepts and natural phenomena is very essential. In spite of the importance of chemistry in nation building, students' attitude, interest and performance in Nigeria Certificate in Education (NCE) level in chemistry in Nigeria for the past two decades have not been encouraging (Abdullah & Scaife, 1997; Odoh, 1998; Iliyasu, 2006). A lot of efforts have been made in research work through conferences, workshops and seminars organized to find solutions to students' poor performance and low interest in chemistry but still the students' academic performance in the subject is below expectations (Onu, 2004). One of the major areas of chemistry that contributes to low performance at NCE level is the organic chemistry as observed by Inikori (2004).

Organic chemistry in its simplest term is the chemistry of carbon compounds, excluding carbon-oxides, metal-carbonyls, metallic carbonates and other related compounds (Inikori, 2004). In other words it is the study of the composition and properties of carbon chain or carbon ring compounds or mixture thereof. Organic chemistry is often referred to as the chemistry of carbon, because all known organic compounds have been found to contain the element carbon (John, 1981). It is a discipline within chemistry which involves the scientific study of the structure, properties, composition, reaction and preparation (by synthesis or by other means) of chemical compounds consisting primarily of carbon and hydrogen, which may contain any number of other elements, including nitrogen, oxygen, the halogens as well as phosphorus, silicon and sulphur.

The original definition of "organic" chemistry came from the misconception that organic compounds were always to life processes. However, organic molecules can be produced by processes not involving life, as it depends on inorganic chemistry. For example, many enzymes rely on transition metals such as iron and copper; and materials such as shells, teeth and bones are part organic, part inorganic in composition. Apart from element carbon, only certain classes of carbon compounds (such as oxides, carbonates, and carbides) are conventionally considered inorganic. Biochemistry deals mainly with the natural chemistry of biomolecules such as proteins, nucleic acids, and sugars.

Because of their unique properties, multi-carbon compounds exhibit extremely large variety of homologous series and the range of application of organic compounds is enormous. They form the basis of, or are important constituents, of many products (paints, plastics, food, explosives, drugs, petrochemicals, to name but a few) and (apart from a very few exceptions) they form the basis of all earthly life processes.

One of the key points of teaching organic chemistry in schools is to attract many young Nigerians to careers which organic chemistry plays an important role e.g. oil industry, food industry (agriculture in general), medical/pharmaceutical, textile, cosmetics. Academically, organic chemistry stands a central position among the basic sciences; there can be an exchange of principles of chemistry with physics and biology. Therefore, most problems that require physics or biological knowledge may also require chemistry principles e.g. pollution, population and agricultural problems (Jimoh, 2002).

Concepts refer to perceived regularities in events or objects designated by some label. It could also be described as mental constructs e.g. an atom (Ezenwa, 1993). Aliyu (1982) define the term concept simply as a word or group of words or symbols which may represent the meaning or definition given to an object or phenomenon. In science; two kinds of concepts exist, empirical and theoretical concepts. Empirical concepts are concepts that are observable or demonstrable, and may be defined operationally. They can be measured in a relatively simple, direct way e.g. atoms, electrons, molecules, genes, protons. While theoretical concepts are non-observable and cannot be perceived or measured in a relatively simple direct way e.g. Atoms, Electrons, Molecules, Genes, and Protons (Aliyu, 1982). For the purpose of this study theoretical concepts are to be examined based on their misconception held by students in tertiary institutions. For example, Aromaticity, Conjugation, Delocalization, Hybridization, Isomarization, and so on.

Misconceptions are meanings or notions or conceptions students have formed about the physical world before instruction that they bring to class, (Ezenwa, 1993). These misconceptions could or could not be in line with scientific way of thinking. Misconception as a term can be more appropriately defined as the privately held knowledge of an individual or individuals that departs significantly from the publicly held version of that knowledge domain and concept (Pines & West, 1986; Simpson, 1989). Several studies on misconception like those of Abimbola and Baba (1996), Martin and Subbarini (1993) show that students' previous knowledge largely determines the number of misconceptions that they hold. Many students wrongly perceived chemistry (particularly organic chemistry) as a difficult subject and feel that studying chemistry means exposure to only corrosive, harmful and toxic substances forgetting that such substances like water, soap, perfumes and so on are chemicals in nature (Onu, 2004).

The low performance of students in senior secondary chemistry generally (WAEC chief examiners report, 1988, 1989, 1990, 1991) makes it a matter of necessity to think about what can be done to improve the situations (misconception), most of the misconceptions will carry it to tertiary institutions which may lead to their poor achievement in organic chemistry (Onu, 2004). Thus, when students at tertiary institutions (NCE) misperceive organic chemistry with incorrect scientific understanding then, the teaching/learning process of chemistry in secondary school will be crippled.

On the other hand, the quality of chemistry education bears a direct relationship with the quality of the chemistry teachers and their methods of teaching. Hence, the purpose of teaching science (chemistry in particular), which is, "to make the students learn to know what they are taught; that is, teachers teach to impart knowledge and skills to students", cannot be justified without the use of appropriate or good method of teaching, Maikano (2007) and Dukawa (2007) also observe that most teaching methods employed at the colleges of education in chemistry teaching is lecture method and this lead to the poor academic achievement in the subject.

With increasing number of studies on misconception (e.g. Kikas, 2004), even if such strategies are effective in correcting misconception, it is difficult for them to be applied to school education as they are because they take too much time compared to traditional teaching-learning methods and are not helpful to those who do not have misconception. Thus it is necessary to establish a teaching strategy, which is highly applicable to school education curricula and effective in correcting misconception, and in which most students are interested.

Effective science teaching depends on the available methods employed by the teachers at different levels on different concepts. These include, laboratory, lecture, discussion, guided discovery, expository, concept mapping, problem solving, field trip, project and demonstration teaching strategies among others. In this study, therefore, demonstration teaching strategy will be employed in the teaching of organic chemistry and to see its effect on shifting misconception students harbored which can affect the academic achievement of colleges of education students.

Demonstration teaching strategy is of key importance in teaching sciences (Vladimir, 2004), and is perhaps even more important in pure chemistry, due to the fact that one may in principle 'activate' all senses in the process of perception of the results of chemical experiments. Demonstrations should be relatively short (as compared with other methods of teaching), performed with the simplest equipment that ensures the same effect and it is vital that the chemistry behind them is well understood at NCE level.

Failure rate in chemistry continue to increase, and female students are not achieving as high as male students in chemistry (Zoller, 1990). Some researchers revealed that female students perform better than the male students (Jegede, 1983), while others reveal that there is no gender difference (Afemike, 1982; Bunkure, 2007). Hence, the issue of gender is still a controversy in the teaching/ leaning process of science. The issue of gender difference is therefore another factor to be investigated in this study in relation to misconception and academic achievement in organic chemistry.

1.2 Statement of the Problem

Researchers in chemistry education, notably Adiqwe (1993), Opobiyi (1994),

Abdullahi (1995) and Jimoh (2002) observe that 20.2% of NCE chemistry curriculum focuses on organic chemistry, while physical, inorganic, analytical and industrial components etc. account for 70.8%. These researchers further identify organic chemistry concepts as the area where students often perform poorly.

Many reasons have been proffered for the poor performance of NCE students in organic chemistry. One of such is the misconception of concepts in organic chemistry held by the students (Nakheh, 1992; Mazur, 1997; Abdullah, 1997). Lack of awareness of the type of misconception in organic chemistry exhibited by students and teachers at tertiary institutions, such as colleges of Education, as well as use of inappropriate teaching methods might be another contributing factor leading to poor academic achievement in chemistry at this level (Jimoh, 2002).

Identification of these misconceptions will be a first step in trying to look for a way to remedy them. It has been shown that if the right approach or method is used in teaching organic chemistry, then problem of misconception can be minimized (Heeman, 2005; Bryan 2007). Theories on the process of the development of misconception and many strategies for correcting misconception have also been carried out (Abdullah, 1997; Heeman, 2005; Bryan, 2007). For example, even if such strategies are effective in correcting misconception, it is difficult for them to be applied to school education as they are because they take too much time when compared to traditional teaching-learning methods (Jimoh, 2002).

Since the study of this nature was relatively new at tertiary institutions; NCE level in particular, the need to investigate the effects of demonstration teaching strategy on students' misconception in relation to their academic performance is therefore appropriate. Specifically, the study investigated the effects demonstration teaching strategy on students' misconceptions in relation to their academic performance in organic chemistry at NCE level.

1.3 Objectives of the Study

The objectives of this study were to:

1. identify the types of misconceptions among NCE students in organic chemistry.
2. investigate the effect of demonstration teaching strategy in remedying the identified misconceptions in organic chemistry at NCE level.
3. investigate the gender differences on misconception in organic chemistry at NCE level.

1.4 Research Questions

In this study the following research questions were answered:

(1) What is the difference between the academic performance of chemistry students exposed to Demonstration teaching strategy and those exposed to Lecture method?.

(2) What is the effect of Demonstration teaching strategy in remedying students' identified misconception in organic chemistry at NCE level?.

(3) What is the effect of Demonstration teaching strategy on Male and Female students in remedying misconception of concepts in organic chemistry?.

1.5 Hypotheses

In carrying out this research the following null hypotheses were tested:

Ho_1: There is no significant difference between the mean scores in organic chemistry misconception test (OCMT) of NCE students taught using demonstration teaching strategy and those taught using lecture method.

Ho_2: There is no significant difference in the types students' misconception in organic chemistry before and after exposure to demonstration teaching strategy.

Ho_3: There is no significant difference between the mean scores in organic chemistry misconception test of male and female NCE students when exposed to demonstration teaching strategy.

1.6 Significance of the Study

This study is significant on the basis of the following:

1. To teachers (in tertiary institutions); the study being relatively new, could be of great importance because the findings of this study can be used to improve their teaching strategies particularly in remedying misconceptions held by students in organic chemistry at NCE level.
2. The students, being potential teachers, may benefit more from the findings of the study; as it will hopefully help them improve their understanding of the identified and related concepts of organic chemistry. Hence, improve their academic performance and be able to teach it effectively.
3. Textbooks publishers may find this study very useful in their presentation and publications of the subject-matter in a form that would facilitate easier understanding

of concepts i.e. remedying misconceptions of concepts. Particularly, in organic chemistry by both teachers and students at NCE level.

1.7 Delimitation of the Study

The study was delimited to only students of chemistry in the colleges of education. This is because the concepts under study were chemistry concepts, and organic chemistry was taught at NCE I, II and III.

Two colleges of education in Kano State (i.e. Sa'adatu Rimi College of education, Kumbotso, and Federal college of education, Kano) were used. This is because the two colleges of education were coordinated and accredited by National Commission for Colleges of Education (NCCE) standard.

Only some concepts in organic chemistry, for example aromaticity, hybridization, isomerism, delocalization and conjugation were taught in this study because these were concepts that had high failure rates among NCE students in organic chemistry (NCCE, 2002). Thus, the findings of the study were limited to the population from which the samples were selected.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The aim of this study is to investigate the effect of demonstration teaching strategy on the remedy of misconception and academic achievement in organic chemistry among students of Kano state colleges of education. This chapter reviews the literature relevant to the study in the following sub-headings;

1. Concepts and Misconception in Science
2. Sources of Students' Misconception
3. Misconception in Chemistry
4. Helping Students Overcome their Misconceptions
5. Science Teaching Methods
6. Demonstration Teaching Strategy of Science
7. Gender and Academic Achievement in Science
8. Related Studies on Misconception and Academic Achievement in Chemistry
9. Implications of Literature Reviewed on the Present Study.

2.2 Concepts and Misconception in Science

Literally, concepts are meaning assigned to given symbols. The symbols may be group of words or chemical/mathematical symbols. Carnap, (1996) classify concepts into the categories; classification, comparative and qualitative. While Abimbola and Danmole (1994), defined concepts as perceived in events or objects designated by an arbitrary label.

Concepts are ideas, notions or thoughts which can be regarded as the emerging image of the mental process (Lakpini, 2006). It may be a product of some intuitive re-appraisal; the only problem is that a concept could be concrete, abstract or even blurred. Pella, (1977) defined concepts as a summary of the essential characteristics of a group of ideas. Stone, (1979) defined concepts as an abstraction from objects, situations or events of the attributes these phenomena have in common. Klausmeir (1972) and Davis (1973) stated that concepts can be defined in a number of ways, which are; structurally, systematically, operationally, axiomatically. Structural definitions look at properties or attributes of a concept. Systematic definitions look at the procedure used to distinguish the concept from other concepts. Axiomatic definitions look at numerical and logical relationship among concepts.

The concepts of misconception can be viewed in different perspectives, but for the purpose of teaching/learning process, misconception can be referred to as an incorrect conception; a mistaken thought, idea or notion (a misunderstanding); badly or wrongly misjudged unfavorably; having a wrong conception or understanding of what is in fact the context of learned concepts, (Ezenwa, 1993). She also defined misconception as misunderstanding which occurred during or as a result of instruction, for example, the concept of hybridization in organic chemistry, and most students cannot differentiate between excited state and the ground state of carbon in an aromatic compound and non-aromatic compound.

2.2.1 Types of Misconceptions.

There are various types of misconceptions in science. A familiar example from elementary school is students understanding of the relationship between the earth and the sun. While growing up, children are told by adults that the "sun is rising and setting", giving them the image of a sun that moves about the earth. In schools, students are told by teachers (years after they have already formed their mental models of how things work) that the earth rotates. Students are then faced with the difficult task of deleting a mental image that makes sense to them, based on their own observations, and replacing it with a model that is not as intuitively acceptable. This task is not trivial, for students must undo a whole mental framework of knowledge that they have used to understand the world (Brown &Clement, 1991). The example of the earth rotating rather than the sun orbiting the earth is one out of many that teachers refer to collectively as misconceptions. Misconceptions can be categorized as follows;

Preconceived Notions – These are popular conceptions rooted in everyday experiences. For example, many people believe that water flowing underground must flow in streams because the water they see on earth's surface flows in streams. Preconceived notions plague/contradict students' view of heat, energy, and gravity (Brown & Clement, 1991), among others. In this study a typical example, is the presence of isomers in a compound which changes its chemical properties; linear structured octane molecule (used as petrol) is not of the same quality when compared with branched chain octane molecule. This is because the octane rating of linear octane is not the same with that of branched chain octane, which has high octane rating due to isomerism.

Nonscientific Beliefs – These include views learned by students from sources other than scientific education, such as religious or mythical teachings. For example, some students have learned through religious instruction about an abbreviated history of the earth and its life forms. The disparity between this widely held belief and the scientific evidence for a far more extended per-history has led to considerable controversy in the teaching of science. (Blackburn, 1995 in STR, 2006)

Conceptual Misunderstandings - these arise when students are taught scientific information in a way that does not provoke them to confront paradoxes and conflicts resulting from their own preconceived notions and nonscientific beliefs. To deal with their confusion, students construct faulty models that usually are so weak that the students themselves are insecure about the concepts. (Benson in STR, 2006). In this case, conceptual misunderstanding result from the teaching method used in chemistry e.g. the normal lecture method which is not able to clarify the conceptual change needed in terms of understanding of concept.

Vernacular Misconceptions- These arise from the use of words that mean one thing in everyday life and another in scientific context (e.g. "work''). A geology professor noted that students have difficulty with the idea that glaciers retreat, because they pictured the glacier stopping, turning around, and moving in the opposite direction. Substitution of the word "melt" for "retreat" helps reinforce the correct interpretation that the front end of the glacier simply melts faster than the ice advances. (Okebukola & Jegede, 1988; Esiobu & soyibo, 1995; in STR, 2006). In this study, most concepts in organic chemistry were misconceived by students due to lack of effective English e.g. some may consider "evaporation" to be equal to "decantation".

Factual Misconception – These are falsities often learned at an early age and retained unchallenged into adulthood. If one think about it, the idea that "lightning never strikes twice in the same place" is clearly nonsense, but the notion may be buried somewhere in leaner's believe system (Zoller,1990). It is now recognized that major efforts to improve science education has fallen short of expectation. Science educator now advocate for change in instructional practices that would take cognizance of students' preconception. It is observed that some instructional strategies proposed to improve science instruction are those using the constructivist view (Ezenwa, 1993). The premise behind the constructivist view is that the learner on the growth of constructs already available to him actively constructs knowledge. In other words, knowledge is not passively built but actively built up by the learner from existing knowledge framework to make meaning (Manzur, 1996). To this regard a large number of influential reports (Iliyasu, 2000; Abdullah, 2006) have claimed the existence of serious short-comings in secondary school science education, which is the backbone of most of the problem hindering the teaching and the learning of sciences, (chemistry in particular) in our tertiary institution, colleges of education inclusive and have proposed major reforms. Blosser (1987) and Jegede (1993) report that only minimal changes have been noticed in the learners, since the introduction of guided discovery in Nigeria. Watt (1990) stated that for years science educators have advocate discovery based instruction, yet student's outcome of discovery instruction have been disappointing. (Ezenwa, 1993).

2.2.2 Sources of Students' Misconception

Many studies (for example, Ivowi, 1984) have shown that students develop their scientific misconceptions from many sources. Those sources have always created inconsistent frameworks or incorrect representation of the scientific concepts. The sources are personal experiences (for example, observation), gender, peer interaction, media, language, symbolic representation, textbooks, laboratory works, environmental, social, religion among others (Posner, 1982).

Sometimes teachers serve as another major source of alternative misconceptions when using inappropriate method of teaching (Wandersee, Mintzes, and Novak, 1994). Researchers such as Lee, (2004) also revealed that students at different ages held similar misconceptions that influence their understanding of more complex concepts. Although there are a growing number of researchers devoting their efforts to science learning, (for example, Schmidt, 1995) science educators have developed instruction interventions for conceptual change in learning science, but they offer only limited representative information about the difficulties/misconceptions held by learners when learning chemistry. Although much research has focused on investigating students' misconception and developing teaching strategies for conceptual change, few researchers have focused on exploring the causes behind the misconceptions. For instance, Herron (1996) argued that language in chemistry can cause or increase misconception because the meanings of the same word in chemistry are different from the language used in daily life. Also, Oversby (2000) argued that models used in textbooks only provide explanations of phenomena, and they have their strengths and limitations in relation to misconception. Accordingly, this study intends to identify the level of students' misconception and find the effect of demonstration method teaching on misconceipt concepts in organic chemistry for example aromaticity, delocalization, conjugation, hybridization, and isomerism.

2.3 Misconceptions in Chemistry

Many concepts in chemistry are important for learning and understanding how the world functions in daily life. However, students, either before or after school instruction, cannot develop an appropriate structure of chemistry concepts. For example, students' misconception of matter as a collection of moving particle is rudimentary, and the instruction in this area is not as effective as might be expected (Gabel & Bunce, 1994). Novick and Nussbaum (1982), examined students' misconception of the particle nature of matter, and found that "a significant portion of the sample failed to internalize important aspects of the particle model". Students tend to consider the particles as having continuous characteristics.

In the "acids and bases" part, Ross and Munby (1991) found that most secondary school students considered that acids tasted bitter and hot. Schmidt (1995) also found that even tertiary schools students have misconception in differentiating acids from bases. Hwang (2004) found that not only students of secondary schools have misconception in identifying whether a substance is an acid or a base, but their teachers had misconception as well. For the concept of chemical equilibrium, Gussarsky and Gorodetsky (1990) reported that even college students had misconception in understanding the dynamic nature of chemical equilibrium. Voska and Heikkinen (2002) found that even college students did not understand or misconceipt how adding a solid to the solution influences the equilibrium state. The effect of oxidation and reduction was also a misconceipt concept for students to conceptualize; students believed that the oxygen that made the iron rust was from the water and that the rested iron had the same weight as the original iron (Hesse & Anderson, 1992). As for the characteristics of matter, Za'rour study (1975) revealed that matter (for example, Mg) decreases its weight after burning. Abraham, Williamson and Westbrook (1994) found that students considered a candle burning to be a physical change and the process of sugar dissolving to be a chemical change. The description of students' misconception described above show that among the many scientific concepts examined within different countries, recursive findings were found at different levels.

Investigations reveal that during the last two decades, these appear to be an increase in the catalogue of topics wrongly perceived by students (Ducan & Johnstone, 1973; Lazonby, 1982; Blosser, 1987; Jegede & Okebukola, 1990; Brown & Clement, 1991). Students' aversion to certain key concepts in (chemistry) is on the increase. In chemistry; concepts of Hybridization, chain reaction, chemical equation, polymerization (Bajah, 1979; Blosser, 1987; Bello, 1990; Eniayeju, 1990) were seen to be wrongly perceived. Failure rate in science/chemistry continue to increase. Moreover the noticeable low performance of students in senior secondary chemistry generally (WAEC chief examiners report, 1988, 1989, 1990, 1991) make it a matter of necessity to think about what can be done to improve the situation, for example, through the use of effective methods for remedying the misconception.

Many researchers, from different parts of the world, such as (Chiu, 2005) agreed that students do not grasp fundamental ideas covered in classroom teaching instructions. Even some of the best students give the right answers but only using correctly memorized words. When questioned more closely, these students reveal their failure to understand fully the underlying concepts. Students are often able to use logarithms to solve numerical problems without completely understanding scientific concept. Manzur (1996), also reported that students in his chemistry class had memorized equations and problem-solving skills, but poorly on tests of conceptual understanding. Nakhleh and Mitchell (1993) studied sixty students in an introductory course for chemistry majors. In an examination, which paired logarithmic problem with a conceptual question on the same topic, only 40% of those students classified as having high logarithmic ability were able to answer the parallel conceptual questions correctly.

2.4 Helping Students Overcome Their Misconceptions

Before misconception can be corrected, they need to be identified. A number of professional societies (such as chemical education international) have developed conceptual tests, which allow teachers to identify students' misconception in chemistry. Additionally, small group discussions and out of office hours provide effective forums for identifying students' misconception. With practice and effort, a teacher can learn to probe students' conceptual framework (often by simply listening) without resorting to authority or embarrassing the student. Mazur (1992) found a way to help students check their conceptual frameworks even within the large lecture format. Hake (1992) used introductory laboratory exercises to help students test their conceptual bases for understanding motion. Essay assignments that ask students to explain their reasoning are useful for detecting students' misconceptions. These essays and discussions need not be used for grading, but rather can be used as part of the learning process to find out what and how the students are thinking. It is useful to review and think about possible misconceptions before teaching a class or laboratory in which new material is introduced. Use questions and discussion to probe for additional misconceptions is quite needed. Students will often surprise you with the variety of their preconceptions, so be careful to listen closely to their answers and explanations. You can help students by asking them to give evidence to support their explanations and by revisiting difficult or misunderstood concepts after a few days or weeks. Misconceptions are often deeply held, largely unexplained, and sometimes strongly defended. To be effective, a science teacher should not underestimate the importance and persistence of these barriers to true understanding. Confronting them is difficult for the students and the teacher. The focus of this study is to give the state of the art in Nigeria of research in misconception of concepts in science and in organic chemistry in particular and suggest direction for future activities.

Some misconceptions can be uncovered by asking students to sketch or describe some object or phenomenon. For example, one might ask students to sketch an atom on a paper before doing so on the board by the teacher; Even students who have a strong background might show a small nucleus surrounded by many electrons circling in discrete orbital paths, much like the solar system. By asking them to draw their own model first and then asking some students to share their answers with the class; a teacher can identify preexisting models and use them to show the need for new model.

2.5 Science Teaching Methods

In the teaching of science / chemistry concepts, there exist today many approaches (Methods) can be used depending on the knowledge, skills and attitudes intended to be imparted. Some of these approaches (methods) include: the Lecture, Discussion, Laboratory, Guided discovery, Expository, Concept mapping, Problem solving, Field trip, and Project.

The lecture method

Lecture method is a method of teaching in which the teacher delivers preplanned lesson to the students with little or no instructional aids. In using this method the teacher talks about science while the student read about science. (Maikano, 2007). Modern lecture method however allows some interactions between the teacher and the learner (Maikano, 2006).

Lecture method will be used in this research as a medium of instruction to the control group. In this, the control group will be introduced to the identified concepts Organic chemistry through the normal classroom interaction. In this method of teaching the teacher will deliver the lesson to the students with little or no instructional aides. Thus, using chalk and duster only.

2.6 *Demonstration teaching strategy*

Demonstration in science involves carrying out science activities to illustrate science concepts or ideas. Demonstration can be carried out by; the teacher alone, the teacher with a student, the student who is knowledgeable in the activity, or an invited guest (NTI, 2006). Demonstration teaching strategy simply means displaying something, for example, when a science teacher shows the action of carbon dioxide on a blue moist litmus paper, he is presenting a demonstration (Abdullah, 2005). In demonstration teaching strategy, a material or apparatus is shown to the students, and a process is verified through this teaching strategy by the teacher. A demonstration is an experiment if it involves a problem, the solution to which is not immediately apparent to the students. The teacher through asking several questions but seldom giving any answer can also give a demonstration inductively. It has been shown (Bunkure, 2007) that students particularly like experimental demonstration because they usually have more action (Bunkure, 2007. teachers should however endeavor to remove from demonstration, all elements of magic “show biz”, or entertainment.

Instructional advantages of demonstration teaching strategy (Aliyu, 1982; Mc Dermott, 1993) were highlighted as follows; i) it can be used to introduce a lesson, and to climax a lesson, it is an attention inducers and a powerful motivator when it is employed to start a lesson, ii) demonstration teaching strategy saves time, where materials and time are very important, iii) the teacher show how to avoid breakages through demonstrations. The teacher also shows the correct use of equipments and apparatus through demonstration, iv) it allows the teacher to use activities that ordinarily would be too dangerous for students to carry out themselves e.g. an activity involving dangerous chemicals.

Demonstration teaching strategy, in this research was used as a medium of instruction to the experiment group to see its efficacy on students' misconception of concepts in organic chemistry. In addition to the advantages mentioned above, Demonstration teaching strategy was used to simplify the teaching of the identified concepts and to find out whether the method can remedy the students misconceptions.

2.7 **Gender and Academic Achievement in Science**

The term "gender" has attracted the attention of many psychologists, biologists, and researchers as a result of which a lot of literature exists on different aspects of the term (Bichi, in Maikano, 2007). In this study, gender and academic achievement in science and chemistry in particular, appears relevant as one of the research questions focused on gender and academic achievement in organic chemistry using lecture and demonstration method of instruction. For this reason, gender and academic achievement in science (chemistry) was reviewed briefly.

Oakley, in Bichi, (2002) define gender as the amount of masculinity and ferminity found in a person and obviously while there are mixtures of both in most human beings, the normal male has a preponderance of masculinity and the normal female has a preponderance of ferminity. Many studies carried out on gender effects on academic achievement (e.g. Stipek, 1996; Dawson, 2000; Haussier & Hoffman, 2002) have led to a number of conflicting conclusions. Some find gender as a relevant factor in academic achievement; other have found that no difference exists between the sexes in this area.

In Nigeria, Bunkure, (2007) showed that there is a significant sex difference in academic achievement in science with male achieving higher than female. It seems therefore that the results in Nigeria favour male students. Thus, studies outside Nigeria supported the males' superiority in academic achievement over female. However, Bunkure (2007), was not in complete agreement with the males' trend in sex differences with regard to achievement in science. Afemike (1982) showed that the performance of students in co- educational schools were better than those in single sex schools. He also found that female in single sex schools had better scores in chemistry than male in single (all male) schools. Inyang (1988), in his study on the construction validation and standardization of integrated science achievement test in junior secondary schools discovered that the males were significantly superior to the females in their performance in science.

2.8 Review of Related Studies on Misconception in Science

Misconceptions are the personal explanations, ideas and opinions about how the natural phenomenon around an individual operates. They can be personal experiences, which affect a learners' view of the world (Lakpini, 2006). Watson and Kopnicek (1990) and Gunstone (1991), have seen misconception as personal constructions, which are formed based on what an individual sees or feels. These experiences have profound effect on the learner's view of the world and exert a starting effect on their willingness and ability to accept other more scientifically grounded explanation of how world works. Mc Dermott (1984) described misconception as the pre- existing ideas about the world and that these initial ideas makes it difficult for students to develop conception more aligned with accepted scientific views.

A number of studies have revealed that student hold misconceived ideas, which have serious implications for science teaching (Driver, 1986; Driver, 1990 & Hewson, 1983). Misconception has also been described in a variety of terms; Novak (1983) considered misconception to be children's science. Hewson, (1982) labeled misconception as alternative framework. Osborne and Freyberg (1985) describe it as preconception. Garamazza, McClosky and Green, (1981) label it as native belief. Claxton, (1987) calls it mini-theory. Wasson and Kopnicek (1990) call it idiosyncratic and personal ideas. McDermott (1984) regards it as pre-existing ideas.

2.9 Implications of Literature Reviewed on the Present Study

Teachers become astonished to learn that despite their best efforts, students do not grasp fundamental ideas covered in class. Even some of the best students give right answers but are only using correctly memorized words. When questioned more closely, these students reveal their failure to understand fully the underlying concepts. (Mazur, 1996).

Recent research as reviewed in this study, like those of Nakheh and Mitchell, 1993; on students' conception of natural phenomena indicates that new concepts cannot be learned if alternative model that explain a phenomenon already exist in the learner's mind. Mayer, (1987), reported that, although scientists commonly view such erroneous models with disdain, they are often preferred by the learner because they seem more reasonable and perhaps more useful for the learner's purpose (McDermott, 1991). These beliefs can persist as lingering suspicions in student's mind and can hinder further learning.

In the literature reviewed, misconceptions can occur in students' understanding of scientific methods as well as in their organization of scientific knowledge for example, student in a science class will often express disappointment that an experiment did not work. They do not fully understand that experiments are a means of testing ideas and hypotheses, not of arriving at an expected result in teaching instructions. To the scientist, an experiment yields a result, which needs to be interpreted. In that sense, each experiment "works", but it may not works as expected.

In many cases students have developed partially correct ideas that can be used as the foundation for further learning (Clement, 1989). However, many students have not developed an appropriate understanding of fundamental concepts from the beginning. The concept of misconception has been reviewed, the way the misconception affects science teaching was also discussion. The effect of misconception on academic achievement was also highlighted.

From the reviewed studies, it shows that there is need to employ an effective teaching strategy to remedy students' misconception in organic chemistry. Vis a viz, their academic achievement at NCE level to see whether the use of lecture method compared to demonstration method can provide the improvement needed. Various method of teaching in science were discussed, for example lecture, discussion, laboratory, guided discovery, concepts mapping approach, problem solving, field trip, project and demonstration teaching strategy, also, their importance and short-comings in teaching and learning of science was highlighted, but the aspect of using these methods in remedying the misconception of concepts in organic chemistry is relatively new. Which this study is indebted to investigate.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The aim of this study was to investigate the effects of demonstration teaching strategy in remedying identified misconceptions held by students in organic chemistry at NCE level. In the last chapter, literature relevant to the study was reviewed. The content of this chapter is discussed under the following sub- headings:

1. Introduction
2. Research Design
3. Population of the Study
4. .Sample and Sampling Procedure
5. Instrumentation
6. Pilot Testing
7. Data Collection Procedure
8. Data Analysis

3.2 Research Design

The research design used for this study was a pretest, posttest, quasi – experimental and control group design. This design was recommended by Mulford, (1996) for a study of this nature. In the design samples were first pretested, in order to determine the groups' equivalence (ability level). The groups were then divided into experimental and control groups. The two groups (experimental & control groups) were also pretested using Organic Chemistry Misconception Test (OCMT), in order to identify and determine their misconception level. Group A (experimental) were then exposed to treatment (i.e. taught using Demonstration teaching strategy) while group B (control) were exposed to lecture method; this lasted for six weeks. After the treatment, the two groups were then post tested using OCMT to see if there is any difference (in misconception and academic performance) between the two groups. The design is illustrated in Figure 3.1.

Fig. 3.1 Design of the Study

EG ⟶ O_1 ⟶ O_2 ⟶ DM ⟶ X_1

CG ⟶ O_1 ⟶ O_2 ⟶ LM ⟶ X_2

Where:

EG = Experimental group.

CG = Control group

O_1 = Pre test (using Organic Chemistry Misconception Test (for ability level))

O_2 = Pre test (using Organic Chemistry Misconception Test (to identify misconception))

X_1 = Post test (using Organic Chemistry Misconception Test (for control group))

X_2 = Post test (using Organic Chemistry Misconception Test (for experimental group))

DM = Demonstration Method of Teaching (treatment).

LM = Lecture Method of Teaching (control).

3.3 Population of the Study

The population of this study comprised the entire NCE II students offering chemistry at Colleges of Education in Kano State, namely:

1. Federal College of Education, Kano.
2. Federal College of Education (Technical), Bichi.
3. Sa'adatu Rimi College of Education, Kumbotso.

There are three Colleges of Education in the state, two of which are Federal Government – owned institutions while one is a state – owned institution. The students under study (Chemistry students) were NCE II students with age range from 18 –25 years and have common education background of Senior Secondary Certificate Examination / Grade II / National Examination Council as their entry qualifications. The NCE II students were selected for the study because they were already exposed to organic chemistry lessons and achievement test for one year. The NCE III students were not used because they were preparing for their final examinations. Details of the population are given in Table 1.

Table 1. Population for the Study

S/N	Name of College	No. NCE II Chem	Male	Female	Total
1	Federal College of Education, Kano	54	32	22	54
2	Federal College of Education (T) Bichi	48	33	15	48
3	Sa'adatu Rimi Coll. of Education Kumbotso, Kano.	72	42	30	72
Total		**174**	**107**	**67**	**174**

SOURCE: Office of the Academic secretary of the colleges.

3.4 Sample and Sampling Procedure

Two Colleges of Education were purposefully selected for the study. Federal College of Education Kano, which was randomly selected out of the two Federal Colleges of Education and one State College of Education, Kumbotso. This was because the third College of Education was a technical College, even though they offered chemistry as one of their major subject combinations.

In order to have a proportionate number of male and female sample, students with similar learning environment were sampled. Thus, the study sample consisted of 126 NCE II chemistry students, out of 174. They were selected by stratified random sampling. This technique was used to ensure a fair representation of various types of variable of interest of this study, such as gender. (Frankel & Willen, 2000).

The proportion of male and female students was equivalent in both the control and experimental groups. The sample size was sufficiently large enough for the experimental study as it conforms to Frankel and Willen (2000), who recommended minimum number of 30 for an experimental research of this nature. The two study groups were located at different locations far apart. This was done in order to avoid students' interaction during the treatment and administration of the research instruments which might affect the result of the study. Thus, the students that formed the control group were selected from Federal College of Education Kano while those in the experimental group were selected from Sa'adatu Rimi College of Education, Kumbotso. Details of the students in the two Colleges of Education are summarized in Table 2.

Table 2 Summary of Samples Selected for the Study.

S/No	Name of College	No of NCE II Chem. Student	Male	Female	Total
1	Fed. Coll. Of Educ. Kano.	54	35	19	54
2	Sa'adatu Rimi Coll. of Educ, Kumbotso.	72	35	37	72
Total		**126**	**70**	**56**	**126**

The total number of the selected subjects was divided into two groups:

i) Experimental group = 72 (i.e. 35 male and 37 female), from Sa'adatu Rimi College of Education, Kano.

ii) Control group = 54 (i.e. 35 male and 19 female), from Federal College of Education, Kano.

3.5 Instrumentation

The instruments that were used for data collection were, Organic Chemistry Misconception Tests (OCMT), used to identify students' misconceptions. It is made up of 20 fill-ins the blank space items. The second was an Achievement Test which consists of the same 20 items but in multiple choice forms. In this, one of the options in each item is the misconception identified using the first OCMT.

The Organic Chemistry Misconception Tests (OCMT)

These instruments were first developed by Mulford (1996), as an inventory for measuring College students' level of misconceptions in first semester general chemistry. They were adapted by the researcher and were validated by experts in chemistry education and a psychologist from Bayero University Kano. That (OCMT) was of two types; the first one consists of 20 short-answer test items on Organic chemistry concepts underlying students' misconception in organic chemistry and it has two sections. Section "A" seeks response on students' personal data such as name, gender, and age, while section B consists of the 20 fill-in the blank space items. This was to enable the researcher to identify and determine the students' misconception at the beginning of the experiment (pretest). The second one consists of the same objective test items on students' misconception in Organic chemistry concepts. This (OCMT) instrument was administered after the two groups were exposed to treatment (posttest). This is to enable the researcher to find the effects of demonstration teaching strategy, as compared to lecture method in remedying students' misconception in organic chemistry. Details of these instruments are given in Appendices I and II.

3.5.1 Validity of the instruments

To ascertain the validity of the instruments in relation to this study, 20 OCMT questions were validated by experts in chemistry education and specialist in psychology; from science education section, Ahmadu Bello University, Zaria, and Bayero University, Kano respectively. Colleagues, currently teaching chemistry in the two colleges of education, were also asked to validate the instruments. They were all asked to:

a) study the instrument and certify if the questions were truly testing the misconceptions and academic achievement of the students respectively.

b) certify if they are appropriate for the level of the students under study

c) check for possible errors in the instruments and suggest corrections.

After the validation exercise, the items in the instruments were found to be satisfactory and met the requirement of content validity, as for the agreement of all the experts and psychologists.

3.6 Pilot Study

The instruments for the study, OCMT were pilot-tested using NCE II chemistry students of Federal College of Education (Technical), Bichi. The instruments were administered twice each, within an interval of two weeks to 48 students of chemistry in that College. The pilot study was to:

i) find out the characteristics of the two instruments through item analysis;

ii) ascertain the appropriateness of the length of time required to answer items in the two tests separately.

iii) ascertain the appropriateness of the wording of OCMT, and

iv) find the reliability of the instruments.

3.6.1 Reliability of the Instruments

A study was conducted to establish the reliability coefficient of the instruments, that is, test re-test reliability method was used. Forty eight NCE II chemistry students (from FCE (Tech) Bichi) were randomly selected for the study. The two tests (OCMT) contained appropriate instructions on how to answer the questions. The two tests were administered at first and second occasions within an interval of two weeks under the same conditions. On each occasion of the tests administration, it took the same 45minutes to answer the questions. The scores of the sample were then recorded in terms of their overall performance and the reliability coefficient of the test and retest scores was computed by means of Pearson Product-Moment Correlation Coefficient (PPMC), r. The reliability formula (Appendices Iva & Iva) was used to ascertain the reliability coefficient (r- value) to determine how reliable the instruments are.

The results of coefficient gave r = 0.91 (1ST OCMT) and r = 0.84 (2ND OCMT), which indicate high correlation (in each case), meaning that the instruments were highly reliable. Details are given in Appendices IVa & IVb.

3.6.2 Selection of Topics Taught in the Study

The topics taught to the subjects consisted of five Organic chemistry concepts.

These include i) Aromaticity

ii) Conjugation

Iii) Delocalization

Iv) Hybridization

V) Isomerism

These topics were taught to the two groups (experimental group and control group), using Demonstration method and Lecture method respectively. The topics were selected for the following reasons;

i) They cut across the chemistry syllabus in the National Commission for Colleges of Education (NCCE) minimum standard for all the Colleges of Education in Nigeria.

ii) They consisted of areas of students difficulty (due to misconception), which leads to students' poor performance in chemistry at NCE level.

iii) They formed a good representation of the major areas of organic chemistry at all levels of NCE chemistry syllabus.

3.7 Data Collection Procedure

Prior to the commencement of the research, both the control and experimental groups were pretested to determine their performance in Organic chemistry for the purpose of comparison and to identify and determine their misconception level. The two groups were then exposed to chemistry instruction based on the concepts of Aromaticity, Conjugation, Delocalization, Hybridization and Isomerism for at least six weeks using normal lecture method for the control group and demonstration teaching strategy (treatment) for the experimental group. The selection of these topics is purposeful because they cut across the entire Organic chemistry course in the NCCE minimum standard.

Post-test Administration

After the six weeks of instruction, the Organic Chemistry Misconception Test (2^{nd} OCMT) was then administered to both control and experimental groups. The administration of the Organic Chemistry Misconception Test (OCMT) to both groups lasted for one hour; the OCMT was scored by the researcher using a carefully prepared and validated marking scheme. The scores were then converted to percentage for the purpose of data analysis.

3.8 Procedure for Data Collection

Treatment in this study is demonstration teaching strategy, used as a means of instruction, in which Organic Chemistry concepts were taught not only for the purpose of defining or explaining the concepts during or after examinations but for the purpose of application and knowledge transfer, i.e. using an idea or knowledge learned in one field to solve a problem in another field. In this, all types of instructional materials available were used to expand/enhance students' understanding and thus, waving out or correcting their misconceptions. For example, designed models, computer in which CDs were run, among others, were used in this method to digest/verify the concepts that were misconceived by the students.

The treatment (Demonstration) Approach was delivered using the following step;

Introduction of the topic: For example, brief explanation of the topic; Aromaticity, conjugation, etc.

Step I: This step involved the verbal explanation of the concepts e.g. definition of Aromaticity, examples of compounds that are aromatic.

Step II: Use of designed models to differentiate between Aromatic compounds and those that were not.

Step III: Computer, CD player or Projector were used to view the pi- electrons used in forming aromatic compounds and their characteristics i.e. Aromaticity.

Step IV: This involved the summary and conclusion of the lesson – evaluation of the lesson which identifies and measure the level of understanding of the student follows immediately.

Details of the treatment were given in Appendix IV.

3.9 Procedure for Data Analysis

The data obtained in this study, were analyzed based on the null hypotheses stated, in chapter one and re-stated below:

Ho_1: There is no significant difference between the mean scores in organic chemistry Misconception Test (OCMT) of NCE students taught using demonstration teaching strategy and those taught using lecture method.

A t-test statistics was used to analyze the data obtained. This is because the samples were of two groups and that the data generated namely; students' scores in Organic Chemistry Misconception Test (OCMT) is a continuous data. The use of t- test was to ascertain whether there is any significant difference between the achievement of experimental and control groups.

Ho_2: There is no significant difference between the students' misconception in organic chemistry before and after exposure to demonstration teaching strategy.

A t-test statistics was also used to analyze the data obtained.

Ho_3: There is no significant difference between the mean scores in Organic Chemistry Misconception Test of male and female NCE students when exposed to demonstration teaching strategy.

To analyze the data, t –test statistics was used, to test the significant difference between the mean scores of the variable stated. The significant level for rejection or retaining the Hypotheses was set at $p > 0.05$

CHAPTER FOUR

ANALYSIS, RESULTS AND DISCUSSION

4.1 Introduction

This study investigated the effects of demonstration teaching strategy in remedying students' misconception in organic chemistry among students of Colleges of Education in Kano State. The data collected was analyzed using the statistical package for social sciences (SPSS) using 0.05 level of significance to reject or retain the hypotheseseing stated.

4.2 Data Analysis and Results

The instrument used for data collection was Organic Chemistry Misconception Test (OCMT). This instrument was used to measure the academic performance of the students in the pretest and posttest for both experimental and control groups. The data obtained in the course of the study were:

i) Achievement scores from pretest for both experimental and control groups

ii) Achievement scores from posttest for both experimental and control groups

iii) Achievement scores from posttest for male and female students in the experimental group.

4.2.1 Comparison of the Posttest Mean Scores (OCMT) on the Misconception of the Experimental and Control Groups

Null Hypothesis 1

Ho_1: There is no significant difference between the mean scores in Organic Chemistry Misconception test (OCMT) of NCE students taught using demonstration teaching strategy and those taught using lecture method.

To test this hypothesis, the posttest scores of the subjects in the experimental and control groups were compared using t-test statistics. Summary of the analysis is presented in Table 3.

Table 3. t-test Comparison of Mean Scores of Posttest (OCMT) on the Misconception of Students in the Experimental and Control Groups.

Group	N	Mean	SD	SE	Df	t-cal.	P value	Remark
Experimental	72	24.97	6.69	3.06				
					123	1.17	0.005	Significant
Control	53	9.11	5.17	3.00				

Significant at 0.05 alpha level (P = 0.005)

From table 3, the calculated P value was 0.005 which is significant at 0.05 alpha level with DF = 123. This means that there is significant difference between the posttest mean scores of the experimental and control groups in favour of the students in experimental group, who were taught organic chemistry concepts using demonstration method. The experimental group achieved significantly higher than the control group, who were taught same organic chemistry concepts using lecture method. This confirms group equivalence between the experimental and control groups at the start of the experiment. Hence the stated null hypothesis was rejected.

4.2.2 Comparison of the Posttest Mean Scores of the Experimental Group before and after Exposure to Demonstration Teaching Strategy

Null Hypothesis 2

Ho_2: There is no significant difference between the students' misconception in organic chemistry before and after exposure to demonstration teaching strategy.

The second null hypothesis of this study was to compare the effect of demonstration teaching strategy in remedying misconception held by students using their academic Performance in organic chemistry. To test this hypothesis the mean scores of the experimental group before and after exposure to demonstration teaching strategy were compared using t-test statistics. Summary of the analysis is in Table 4.

Table 4. t-test Comparison of Mean Scores of the Experimental Group before and after Exposure to Demonstration Teaching Strategy.

Variables	N	Mean	SD	SE	Df	t-cal.	P value	Remark
Before Treatment	72	11.00	4.43	2.21				
					142	7.09	0.001	Significant
After Treatment	72	24.97	6.69	3.06				

Significant at 0.05 alpha level (P = 0.001)

From Table 4, the calculated P value is 0.001 which is significant at 0.05 alpha level with DF = 142. This means that there is a significant difference between the posttest and pretest means scores of the experimental group after treatment. That is, students achieved significantly higher when taught organic chemistry concepts using demonstration teaching strategy. Thus, the stated hypothesis was rejected.

4.2.3 Analysis of Posttest Mean Scores of Male and Female Students in the Experimental Group when Exposed to Demonstration Teaching Strategy.

Ho_3 :- There is no significant difference between the mean scores in organic chemistry misconception test of male and female students when exposed to demonstration teaching strategy at NCE level.

To test this hypothesis the mean scores of the male and female students who were exposed to demonstration teaching strategy were calculated and subjected to t-test compared on the basis of gender. Summary of the analysis is presented in Table 5.

Table 5. t-test Analysis of Posttest Mean Scores of Male and Female Students in the Experimental Group Exposed to Demonstration Teaching Strategy.

Group	N	Mean	SD	SE	Df	t-cal.	P-value	Remark
Male	40	26.00	2.12	4.50				
					70	2.81	0.90	Not significant
Female	32	25.00	2.36	4.00				

* Not significant at 0.05 alpha level (P = 0 .90)

From Table 5, the P-value is 0.90 which is greater at 0.05 alpha level with Df = 70. The null hypothesis is therefore retained. This means that there is no significant difference between the mean scores of male students and their female counterparts when taught organic chemistry concepts using demonstration teaching strategy. This implies that both male and female students performed equally well after exposure to demonstration teaching strategy. Therefore, demonstration teaching strategy is gender friendly.

4.3 Summary of Findings

The findings of the study are as follows:

1. There is a significant difference in academic achievement of students when exposed to Demonstration teaching strategy which implies that demonstration teaching strategy is an effective teaching strategy
2. There is a significant difference in the misconception of concepts in organic chemistry of students after exposure to demonstration teaching strategy, which shows that demonstration teaching strategy is capable of remedying students' misconception of concepts in organic chemistry.
3. There is no significant difference in the performances of male and female students when exposed to demonstration teaching strategy in the teaching of concepts of organic chemistry at NCE level. Thus, demonstration teaching strategy is gender friendly.

4.4 Discussion of Results

This study investigated the effects of demonstration teaching strategy in remedying students' misconception of concepts in organic chemistry and their academic achievement. The results obtained were discussed as follows;

Hypothesis 1 was stated to find out if there is any significant difference in the academic achievement of the two groups when exposed to demonstration teaching strategy (for experimental group) and lecture method (for control group). The results from data analyses showed that there is significant difference in the means scores of the two groups in favour of those taught using demonstration teaching strategy. Demonstration teaching strategy was reported in this study to enhance students' academic achievement in the subject as observed in the performance of students after they had been exposed to demonstration teaching strategy. This observation is in line with Okebukola (1990), who reported that demonstration teaching strategy is a strong motivational device for students and it was further reported that it can broaden the scope of the scientific content. Thus, demonstration teaching strategy is an effective method for both male and female students, particularly in remedying misconception of concepts in organic chemistry.

From the analysis of data to test hypothesis 2, it was empirically shown that demonstration teaching strategy significantly remedied misconception of students' concepts in organic chemistry, as shown from their higher performance in the posttest. This finding is in line with those of Ezenwa (1993), Mazrur (2004) Ebenezer (2005), who agreed that practical exploration and experimental activities which are parts of demonstration teaching strategy, leads to a constant interplay between students and teachers which leads to effective learning.

A significant finding based on the third Hypothesis of this study is that the male students performed equally well with the female students (in the experimental group) when both were exposed to demonstration teaching strategy. The finding of this study is in line with that of Afemike (1982); where no significant difference was observed between the males and females students academic performance in science.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The effects of demonstration teaching strategy in remedying misconceptions of concepts in organic chemistry among NCE II students of Colleges of Education in Kano State were investigated, and the data collected were analyzed and discussed in chapter four. This chapter focuses on the summary, major findings, conclusions, implications of the study and recommendations. The chapter is specifically presented under the following sub-headings;

1. Summary
2. Summary of Findings
3. Conclusions
4. Recommendations
5. Limitations of the Study
6. Suggestions for Further Study

5.2 Summary

The purpose of this study was to investigate the effects of demonstration teaching strategy in remedying misconceptions in Organic Chemistry among Colleges of Education students. The study samples were hundred and twenty six (126) students randomly selected from a population of one hundred and seventy four (174) NCE II students from all colleges of education in Kano State. Two out of the three colleges were pre-tested with Organic Chemistry Misconception Test and the samples were then designated as control and experimental groups.

Students from FCE Kano were designated to be the control group while students from Sa'adatu Rimi College of Education were assigned to be the experimental group.

Two instruments were used for the study namely; Organic Chemistry Misconception Test (1^{st} OCMT) based on the concepts of organic chemistry which was formed from the past question papers of NCCE minimum standard. The second instrument was the Organic Chemistry Misconception Test (2^{nd} OCMT) which was developed based on the concepts of Aromaticity, Conjugation, Delocalization, Hybridization and Isomerism. The hypotheses were tested with t-test statistical technique using SPSS (16) Statistical Software for Social Sciences at 95% confidence level, and the following findings were made:

Analysis of Data in Relation to Ho_1: This revealed that academic achievements in organic chemistry are not common among the two groups after the experiment; there is significant difference in the academic achievements of students after exposure to demonstration teaching strategy (experimental group) and lecture method (control group) at NCE level. Thus, the stated hypothesis was rejected.

Analysis of Data in Relation to Ho_2: This revealed that in the case of students exposed to demonstration teaching strategy and those exposed to lecture method; a significant difference in misconception of concepts, in favour of the experimental group. The stated hypothesis was thus rejected at 95% confidence level. In addition, analysis of Data in Relation to Ho_2, revealed that there is a significant change in students' misconception of concepts in Organic Chemistry after exposure to demonstration teaching strategy. The stated hypothesis was thus, rejected at p-value less than or equal to 0.05.

Analysis of Data in Relation to Ho_3: This revealed that there was no significant difference in academic achievement of male students as compared to their female counterparts. Hence hypothesis 3 was thus, retained at 95% confidence level. In other words, analysis of Data in Relation to Ho_3, confirmed that there was no significant difference in the misconception of concepts in organic chemistry between the male and female students in the experimental group; i.e. Demonstration teaching strategy is gender friendly, particularly in remedying students' misconception of concepts in organic chemistry.

5.3 Summary of Findings

At the end of this study, the following findings were made;

1. There is a significant difference in the academic achievement of students taught organic chemistry via demonstration teaching strategy and those taught the same via lecture method, in favour of demonstration teaching strategy.

2. There is a significant change in students' misconception after exposure to demonstration teaching strategy i.e. demonstration teaching strategy is effective in remedying students' misconception.

3. There is no significant difference in the mean scores of academic achievement of male students as compared to their female counterparts.

5.4 Conclusions

On the basis of the findings of the study the following conclusions were drawn: -

(i) The students that were taught organic chemistry concepts using demonstration teaching strategy performed significantly better/higher than those taught the same organic chemistry concepts using the chalk and talk (lecture) method. Thus demonstration teaching strategy enhances academic achievement in organic chemistry among NCE II students

(ii) The use of demonstration teaching strategy in teaching organic chemistry leads to more positive perception and quality of instruction than the use of lecture method i.e. demonstration teaching strategy is effective in remedying students' misconception in organic chemistry at NCE level.

(iii) There was no significant difference in the academic achievement of male and female students taught organic chemistry concepts using demonstration teaching strategy. This means demonstration teaching strategy is gender friendly.

(iv) The use of demonstration teaching strategy to conventional instruction in organic chemistry produces higher academic achievement than the use of chalk and talk method, that is the use of chalk and talk method should be discouraged in organic chemistry lessons. This will help students overcome their misconceptions of concepts in organic chemistry and will also help in its learning more effectively.

5.5 Recommendations

On the basis of the findings arising from the study, the following recommendations are made:

(i) The use of Demonstration Teaching strategy in chemistry instruction in tertiary institutions should be encouraged as it is empirically established that it enhances academic achievement among students.

(ii) Since demonstration teaching strategy requires the use of instructional materials, Schools and Colleges of Education should be equipped with modern facilities and instructional packages to enable the teachers/tutors carry out their lesson via demonstration teaching strategy.

(iii) All science teachers and particularly chemistry teachers should be encouraged or facilitated to use demonstration teaching strategy. All science teachers, chemistry in particular, should learn to use modern instructional materials; models, media technology, ICT, among others. This is to enable them carry-out demonstration teaching strategy effectively in combating students' misconception of concepts in organic chemistry.

(iv) In-service training should be given to all chemistry teachers/tutors in tertiary institutions in order to ascertain their capability to carry-out demonstration teaching strategy instead of lecture method.

(v) To this end, the Federal and State Ministries of Education, NCCE and professional organization such as Science Teachers Association of Nigeria (STAN), Chemical Society of Nigeria (CSN), Institute of Chartered Chemist of Nigeria (ICCON), among others, should organize regular workshops, seminars and conferences for chemistry teachers, in order to enhance the use of Demonstration teaching strategy for the remedy of students' misconception of concepts in chemistry, particularly organic chemistry among NCE students.

5.6 Limitations of the Study

The study has the following limitations;

1. Lack of sufficient quantity of the instructional materials (computers, models, etc) needed for demonstration teaching strategy to go round all the study samples in the course of the study.
2. The sample size was inevitably large as compared to the quantity of the instructional materials used for effective demonstration teaching strategy.
3. The study was limited to only five concepts in organic chemistry.
4. Only two colleges of Education in the same state were used because of limited resources and financial constrains. A larger sample size may be more reliable.

5.7 Suggestions for Further Study

1. The effects of Demonstration teaching strategy need to be properly used in all our colleges of education in order to remedy students' misconception. It is therefore suggested that this study be replicated in other colleges of education across the nation.

2. This kind of study should be undertaken in other subject areas with a bigger sample for wider generalization.

3. Students' interest and gender differences need to be further investigated as per the need to remedy their misconception of concepts.

Finally, studies of this nature need to be sponsored not only by government but also by private organization in order to increase the quality of publications worldwide, which will in turn increase the quality of science education in general.

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APPENDIX I

ORGANIC CHEMISTRY MISCONCEPTION TEST (1st OCMT)

INSTRUCTION: Each question carries two marks, write your answer in the space provided. Candidates are at liberty to write their name or not. *TIME ALLOWED:* One (1) hour.

AD. No. …………………… Level ……………… College ………………. Sex …………..

1) Aromatic compounds are classified into two major groups;
   i) …………………………………… ii) ………………………………………..
2) The molecular orbital theory regards all the six carbon atoms in benzene ring as
   …………………………………………………………………………………….
3) The term Phenol is referred to as Aromatic compound in which;

   ……………………………………………………………………………………..

4) Any group of six electrons that form an Aromatic compound is called

   ………………………………………………………………………………………

5) Give any two properties for the structural requirement of Aromaticity;
   ……………………………………………………………………………………..
6) Conjugated diene behave like benzene due to;
   ………………………………………………………………………………………
7) All Carbon – Carbon double bonds in alternative form within a linear or cyclic compounds are called; …………………………………………………………...
8) Compounds with conjugated double bonds prepares;
   …………………………… reaction rather than ……………………………………...
9) The nice odour of Rose flower is due to; ……………………………………………..

10) The reaction of Benzene ring with an Electrophile is a typical example of;

    ………………………………………………………………………………………

11) What is the Hybridization of each of the Carbon atoms in C = C – C

    ………………………………………………………………………………………

12) All Carbon - Carbon bonds in linear Pentane are;

    ……………………………………………………………………………………...

13) Draw the resonance hybrid of Benzene structure,

    i) ………………………………………………………………………………
    ii) ………………………………………………………………………………

14) The number of Pi – electrons in the Benzene ring is,

………………………………………………………………………………………..

15) The Carbon – Carbon triple bond in Ethyne is ………………. Hybridized;

16) The possible isomers found in Para – Toluene are;

………………………...

17) Two classes of Isomerism are,

i) ……………………………….. ii) ……………………………………………

18) The possible Canonical structures of Benzene are;

i) ………………………………………………………………………………

ii) ………………………………………………………………………………

19) Enantiomers are referred to as Isomers that are;

……………………………………………………………………………………

……………………………………………………………………………………

20) Compounds of the same molecular formula but differs in their bond arrangement are refers to as……………………………………………………………………….

APPENDIX Ib

ORGANIC CHEMISTRY MISCONCEPTION TEST (1st OCMT)

MARKING SCHEMES

1. Benzonoid and Non Benzonoid
2. SP^2 – Hybridized
3. OH – attach to benzene ring
4. Sextet
5. Planar and Cyclic
6. Presence of Pi – electrons
7. Conjugated bond
8. Substitution reaction
9. Ester
10. Substitution reaction
11. SP^2 and SP^3 Hybridized
12. SP3 Hybridized
13.
14. Six (6)
15. SP – Hybridized
16. Ethyl benzene
17. Structural and Geometrical
18.
19. Mirror image
20. Structural isomerism.

APPENDIX II

ORGANIC CHEMISTRY MISCONCEPTION TEST (2^{nd} OCMT)

INSTRUCTION: Each question carries two marks and is followed by four options; A, B, C and D. Choose the option that best answer the question and cycle the letter that carries the answer on the question paper. Candidates are at liberty to write their name or not. *TIME ALLOWED:* One (1) hour

AD. No. …………………… Level ……….. College …..……………. Sex ………………

1) Aromatic compounds are classified into two major groups;
   a) Benzonoid and Non Benzonoid b) Cyclic and Acyclic

   c) Ring and Straight chain d) Aliphatic and Non aliphatic

2) The molecular orbital theory regards all the six carbon atoms in benzene ring as
   a) SP^4 – Hybridized b) SP^3 – Hybridized c) SP^2 – Hybridized d) SP - Hybridized
3) The term Phenol is referred to as Aromatic compound in which;
   a) OH – attach to benzene ring b) NO2 – attach to benzene ring

   c) SO2 – attach to benzene ring d) Br – attach to benzene ring.

4) Any group of six electrons that form an Aromatic compound is called
   a) Cyclic b) Sextet c) Hexatet d) Arenes
5) Give any two properties for the structural requirement of Aromaticity;
   a) Hydrogen and Carbon b) Cyclic and Double bond
   b) c) Planar and Cyclic d) Cyclic and Polymerization
6) Conjugated diene behave like benzene due to;
   a) Presence of Pi – electron b) Presence of Pi – bond
   b) c) Presence of Sigma bond d) Presence of Carbon
7) All Carbon – Carbon double bonds in alternative form within a linear or cyclic compounds are called;
   a) Benzene ring b) Hydrogen bond c) Pi – bond d) Conjugated bond
8) Compounds with conjugated double bonds prepares;
   a) Addition reaction b) Elimination reaction

   c) Substitution reaction d) Rearrangement reaction

9) The nice odour of Rose flower is due to;
   a) Citric acid b) Ester c) Lactic acid d) Ether
10) The reaction of Benzene ring with an Electrophile is a typical example of;
   a) Addition reaction b) Elimination reaction

c) Rearrangement reaction   d) Substitution reaction

11) What is the Hybridization of each of the Carbon atoms in C = C – C
a) SP^2 and SP^3 b) SP^2 and SP   c) SP^3 and SP   d) SP^3 and SP^4

12) All Carbon - Carbon bonds in linear Pentane are;

a) SP – Hybridized b) SP^2 – Hybridized c) SP^3 – Hybridized d) sp^4 – Hybridized

13) Draw the resonance hybrid of Benzene structure,

a)   b)

c)   d)

14) The number of Pi – electrons in the Benzene ring is,

a) 12   b) 8   c) 6   d) 4

15) The Carbon – Carbon triple bond in Ethyne is ………………. Hybridized;

a) SP^4 b) SP^3 c) SP^2 d) SP

16) The possible isomers found in Para – Toluene are;

a) Ethyl benzene b) Methylbenzene c) Propylbenzene d) Butyl benzene.

17) Two classes of Isomerism are,

a) Functional and Structural   b) Identical and Non identical

c) Structural and Geometrical   d) Functional and Identical

18) The possible Canonical structures of Benzene are;

a)   B)

c)   d)

19) Enantiomers are referred to as Isomers that are;

a) Supper impossible   B) Mirror image
b) c) Structurally isomeric   d) Structurally equal

20) Compounds of the same molecular formula but differs in their bond arrangement are refers to as,

a) Stereoisomerism b) Geometric isomerism

c) Structural isomerism d) Optical isomerism

APPENDIX IIb

ORGANIC CHEMISTRY MISCONCEPTION TEST (2^{nd} OCMT)

MARKING SCHEMES

1. A = Benzonoid and Non Benzonoid
2. C = SP^2 – Hybridized
3. A = OH – attach to benzene ring
4. B = Sextet
5. C = Planar and Cyclic
6. A = Presence of Pi – electrons
7. D = Conjugated bond
8. C = Substitution reaction
9. B = Ester
10. D = Substitution reaction
11. A = SP^2 and SP^3 Hybridized
12. C = SP3 Hybridized
13. D =
14. C = Six (6)
15. D = SP – Hybridized
16. A = Ethyl benzene
17. C = Structural and Geometrical
18. D =
19. B = Mirror image
20. C = Structural isomerism.

APPENDIX III

PRE-TEST (1st OCMT) EXPERIMENTAL GROUP RESULT

S/No	SCORES/40	GENDER
01	18	Male
02	14	Male
03	20	Male
04	18	Male
05	20	Male
06	18	Male
07	12	Female
08	12	Male
09	14	Male
10	10	Male
11	18	Male
12	14	Male
13	16	Male
14	12	Male
15	18	Male

16	16	Male
17	14	Male
18	12	Female
19	18	Male
20	16	Male
21	14	Male
22	14	Male
23	18	Male
24	12	Male
25	14	Male
26	14	Male
27	12	Female
28	12	Female
29	20	Male
30	16	Male
31	16	Female
32	14	Male
33	20	Male
34	12	Male
35	14	Female
36	14	Female
37	12	Female
38	20	Male

39	14	Male
40	18	Male
41	20	Male
42	18	Female
43	18	Female
44	20	Female
45	12	Female
46	12	Female
47	14	Female
48	10	Female
49	16	Male
50	14	Male
51	12	Male
52	18	Female
53	16	Female
54	14	Female
55	11	Female
56	12	Female
57	10	Female
58	16	Female
59	16	Female
60	16	Female
61	20	Female

62	14	Female
63	12	Female
64	18	Female
65	14	Female
66	12	Female
67	11	Female
68	15	Female
69	12	Female
70	18	Female
71	15	Female
72	17	Female

APPENDIX IIIb

PRE-TEST (1st OCMT) CONTROL GROUP RESULTS

S/No	SCORES/40	GENDER
01	12	Female
02	20	Female

03	20	Female
04	14	Female
05	12	Female
06	10	Female
07	06	Female
08	18	Male
09	10	Male
10	14	Male
11	10	Female
12	12	Female
13	14	Female
14	14	Female
15	12	Female
16	20	Male
17	10	Male
18	14	Female
19	14	Male
20	10	Male
21	12	Male
22	09	Male
23	18	Male
24	12	Female
25	18	Female

26	08	Male
27	14	Female
28	12	Male
29	15	Male
30	12	Male
31	14	Male
32	16	Male
33	15	Male
34	08	Male
35	12	Male
36	10	Male

37	13	Female
38	06	Female
39	12	Female
40	08	Male
41	18	Male
42	14	Male
43	10	Male
44	17	Male
45	09	Male
46	17	Male
47	12	Male
48	12	Male
49	06	Male
50	08	Male
51	10	Male
52	14	Male
53	12	Male
54	16	Male

APPENDIX IVa

POST-TEST (2nd OCMT) EXPERIMENTAL RESULT

S/No	SCORES/40	GENDER
01	28	Male
02	28	Male
03	30	Male
04	28	Male
05	30	Male
06	28	Male
07	22	Female
08	32	Male
09	24	Male
10	30	Male

11	28	Male
12	24	Male
13	26	Male
14	32	Male
15	28	Male
16	26	Male
17	34	Male
18	32	Female
19	28	Male
20	26	Male
21	24	Male
22	24	Male
23	28	Male
24	32	Male
25	24	Male
26	34	Male
27	32	Female
28	32	Female
29	30	Male
30	26	Male
31	26	Female
32	24	Male
33	30	Male

34	32	Male
35	34	Female
36	24	Female
37	32	Female
38	30	Male
39	24	Male
40	28	Male
41	30	Male
42	28	Female
43	28	Female
44	30	Female
45	22	Female
46	32	Female
47	24	Female
48	30	Female
49	26	Male
50	24	Male
51	32	Male
52	28	Female
53	26	Female
54	24	Female
55	31	Female
56	32	Female

57	30	Female
58	26	Female
59	26	Female
60	26	Female
61	30	Female
62	34	Female
63	32	Female
64	28	Female
65	34	Female
66	32	Female
67	31	Female
68	35	Female
69	32	Female
70	28	Female
71	25	Female
72	27	Female

APPENDIX IVb

POST-TEST (2^{nd} OCMT) CONTROL GROUP RESULTS

S/No	SCORES/40	GENDER
01	22	Female
02	20	Female
03	20	Female
04	14	Female
05	12	Female
06	20	Female
07	06	Female
08	18	Male
09	20	Male
10	14	Male
11	20	Female
12	12	Female
13	14	Female
14	14	Female
15	12	Female
16	20	Male
17	10	Male
18	14	Female
19	14	Male
20	10	Male

21	12	Male
22	19	Male
23	18	Male
24	12	Female
25	18	Female
26	18	Male
27	14	Female
28	12	Male
29	15	Male
30	12	Male
31	14	Male
32	16	Male
33	15	Male
34	18	Male
35	12	Male
36	20	Male

37	13	Female
38	16	Female
39	12	Female
40	18	Male
41	18	Male
42	14	Male
43	20	Male
44	17	Male
45	19	Male
46	17	Male
47	12	Male
48	12	Male
49	16	Male
50	18	Male
51	20	Male
52	14	Male
53	12	Male
54	16	Male

APPENDIX V

CALCULATION OF RELIAVILITY OF ORGANIC CHEMISTRY ACHIEVEMENT TEST (1st OCMT) AFTER TEST AND RETEST ADMINISTRATION

USING PPMCC STATISTICS.

S/N	TEST SCORES TEST (X)	TEST (Y)	X^2	Y^2	XY
01	08	10	64	100	080
02	14	12	196	144	168
03	14	12	196	144	168
04	16	14	256	196	224
05	18	20	324	400	360
06	18	16	324	256	288
07	10	12	100	144	120
08	10	10	100	100	100
09	12	13	144	169	156
10	16	18	256	324	288
11	18	16	324	256	288
12	08	10	64	100	080
13	18	18	324	324	324
14	18	16	324	256	288
15	12	15	144	225	180
16	10	08	100	64	080
17	12	10	144	100	120

18	18	16	324	256	288
19	10	12	100	144	120
20	12	08	144	64	096
21	12	14	144	196	168
22	16	14	256	196	224
23	12	14	144	196	168
24	14	12	196	144	168
25	16	18	256	324	288
26	15	14	225	196	210
27	12	12	144	144	144
28	13	12	169	144	156
29	12	10	144	100	120
30	17	18	289	324	306
31	12	08	144	64	096
32	18	15	324	225	270
33	12	15	144	225	180
34	12	10	144	100	120
35	10	14	100	196	140
36	09	10	81	100	090
37	08	10	64	100	080
38	12	10	144	100	120
39	14	12	196	144	168
40	17	18	289	324	306

41	12	10	144	100	120
42	11	08	121	64	088
43	12	14	144	196	168
44	11	12	121	144	132
45	10	10	100	100	100
46	10	08	100	64	080
47	10	12	100	144	120
48	17	16	289	256	272
TOTAL	608	616	8668	8376	8418

$$r = \frac{N\sum XY - \sum X \sum Y}{\sqrt{\left[N\sum X^2 - (\sum X)^2\right]\left[N\sum Y^2 - (\sum Y)^2\right]}}$$

Where r = coefficient of reliability

N = Number of students

$$r = \frac{48 \times 8418 - 608 \times 616}{\sqrt{(416064 - 369664) \times (402048 - 379456)}}$$

$$= \frac{404064 - 374528}{\sqrt{46400 \times 22592}}$$

$$= \frac{29536}{32373}$$

$= 0.9123$ **r = 0.91**

APPENDIX Vb

CALCULATION OF RELIAVILITY OF ORGANIC CHEMISTRY MISCONCEPTION TEST (2nd OCMT) AFTER TEST AND RETEST ADMINISTRATION

USING PPMCC STATISTICS.

	TEST SCORES				
S/N	TEST (X)	TEST (Y)	X^2	Y^2	XY
01	14	14	196	196	196
02	12	14	144	196	168
03	18	16	324	256	288
04	10	18	100	324	180
05	12	18	144	324	216
06	12	10	144	100	120
07	16	10	256	100	160
08	10	12	100	144	120
09	18	16	324	256	288
10	12	18	144	324	216
11	10	08	100	064	080
12	12	18	144	324	216
13	14	18	196	324	218
14	18	12	324	144	252
15	10	10	100	100	100
16	10	12	100	144	120

17	16	18	256	324	288
18	14	10	196	100	140
19	12	12	144	144	144
20	14	12	196	144	168
21	18	16	324	256	288
22	08	12	064	144	064
23	18	14	324	196	252
24	08	16	064	256	128
25	14	15	196	225	210
26	14	12	196	144	168
27	16	13	256	169	208
28	18	12	324	144	216
29	18	17	324	289	306
30	10	12	100	144	120
31	10	18	100	324	180
32	12	12	144	144	144
33	16	12	256	144	192
34	18	10	324	100	180
35	08	09	064	081	072
36	18	08	324	064	144
37	18	12	324	144	216
38	12	14	144	196	168
39	10	17	100	289	170

40	12	12	144	144	144
41	18	11	324	324	198
42	10	12	100	100	120
43	12	11	144	144	132
44	12	10	144	144	120
45	16	10	256	256	160
46	12	10	144	100	120
47	14	17	196	196	238
48	16	13	256	256	208
TOTAL	650	633	9292	9149	8544

$$r = \frac{N\sum XY - \sum X \sum Y}{\sqrt{\left[N\sum X^2 - (\sum X)^2\right]\left[N\sum Y^2 - (\sum Y)^2\right]}}$$

Where r = coefficient of reliability

N = Number of students

$$r = \frac{48 \text{ X } 8544 - 650 \text{ X } 633}{\sqrt{(446016 - 422500) \text{ X } (439152 - 400689)}}$$

$$= \frac{410112 - 400450}{\sqrt{423516 \text{ X } 38463}}$$

$$= \frac{9662}{40360}$$

= 0.839393 **r = 0.84**

APPENDIX VIa

WEEK I: **Lesson plan I: for the experimental group**

SUBJECT: Chemistry

CLASS: NCE II Chemistry

SEX: Mixed

TOPIC: Organic Chemistry

SUB-TOPIC: Aromaticity

INST. MATERIALS: organic chemistry molecular models

METHOD: Demonstration Method

BEH. OBJECTIVES: By the end of the lesson, students should be able to define, identify the characteristics of aromatic compounds, differentiate between aromatic and non aromatic compounds and give examples.

INTRODUCTION: The teacher introduces the lesson through the following questions;

i) What are Hydrocarbons?
ii) What are the classes of Hydrocarbon?
iii) What are Aromatic compounds?
iv) What is Benzene and why is it Aromatic?
v) What is Aromaticity?.

PRESENTATION: The teacher presents the lesson through the following steps;

STEP I: This involved defining the term Aromaticity using the answers given above e.g. Aromaticity simply refers to the characteristics properties of Aromatic compounds; the ability of a compound to sustain an induced ring current etc.

STEP II: This involved the use of models to exemplify the sustenance of ring current of electrons and also give examples of compounds having such characteristics e.g. Benzene, cyclopropene, Butadiene etc.

STEP III: This involved students' activity; to demonstrate the construction of similar compounds that are Aromatic in nature using the designed models (appendix X) e.g. 2-electron system, 6-electron system, 10-electron system etc.

STEP IV: Identification of the characteristics of Aromatic compounds will then follow; they must be planner and cyclic, unusual stability due resonance of delocalized electrons, must obey Huckel's rule etc.

STEP V: This includes conclusion and summary of the lesson – Evaluation of the lesson which identifies and measure the level of students' understanding follows immediately.

APPENDIX VIb

WEEK I: **Lesson plan I: for the control group**

SUBJECT: Chemistry

CLASS: NCE II Chemistry.

TOPIC: Organic Chemistry

SUB-TOPIC: Aromaticity

BEH. OBJECTIVES: By the end of the lesson, students should be able to define, identify the characteristics of aromatic compounds, differentiate between aromatic and non aromatic compounds and give examples.

METHOD: Lecture Method

INTRODUCTION: The teacher introduces the lesson through the following statements;

i) Hydrocarbons are compounds containing carbon and hydrogen only
ii) Hydrocarbons are broadly divided into; saturated and unsaturated; these are further classified into four: Alkanes, Alkenes, Alkynes and Aromatics.

Etc.

PRESENTATION: The teacher presents the lesson through the following steps;

STEP I: The teacher defined the term Aromaticity e.g. the characteristic properties of Aromatic compounds; the ability of a compound to sustain an induced ring current etc. The teacher further explains the characteristics of Aromatic compounds to the students through the chalk and duster method. Examples of Aromatic compounds are also given by the teacher theoretically.

STEP II: This involved further explanations on the characteristics of Aromatic compounds and the differences between Aromatic and Non Aromatic compounds. Examples were also given (all is done by the teacher).

STEP III: Conclusion and summery were carried out by the teacher and the students were allowed to ask questions when necessary. Further discussions were all based on students' questions and need. In lecture method, students were made to be passive learners.

STEP IV: At the end of the lesson students were either given assignment or notes for further readings.

APPENDIX VIc

WEEK II **Lesson plan II: for experimental group**

SUBJECT: Chemistry

CLASS: NCE II Chemistry.

TOPIC: Organic Chemistry

SUB-TOPIC: Conjugation

INST. MATERIALS: Organic chemistry molecular models

METHOD: Demonstration Method

BEH. OBJECTIVES: By the end of the lesson students should be able to define, explain and give examples of different types of organic compounds with conjugated bonding e.g. Alkenes; 1, 3 – butadiene. Aromatic compounds; Benzene, Anthracene, etc.

INTRODUCTION: The lesson will begin through the following questions, which are related to the students' previous knowledge:

i) Name the four classes of Hydrocarbons,
ii) Alkenes are unsaturated. Why?,
iii) What is conjugation?.

PRESENTATION: The teacher presents the lesson through the following steps;

STEP I: Answers to the above questions will be discussed to enable the teacher present the new topic easily. In this the molecular models will be introduced to apprehend the discussion.

STEP II: The models will now be used to demonstrate the formation double bonds in different ways e.g.

i) Double bond followed by double bond……….. = cumulative bonding.
ii) Double bond followed by single bond and single bond………. = isolated bonding.
iii) Double bond followed by single bond and double bond then single bond……… = conjugated bonding. (refer to Appendix V)

STEP III: This involved the construction of different types of compounds that has conjugation in its bonding e.g. 1, 3 – Butadiene, Naphthalene, Anthracene,

1, 3, 5, - Hexatriene etc.

STEP IV: The main characteristics feature of conjugated double bonds as compared to other forms of double bonding is the formation of ring of -electrons i.e. Aromaticity. This will be verified using the models in the examples given above.

STEP V: In this, the lesson is concluded, summarized and evaluated. Students are allowed to repeat any of the demonstration exercise that is not cleared or is daughtful.

APPENDIX VId

WEEK II **LESSON PLAN II: for control group**

SUBJECT: Chemistry

CLASS: NCE II Chemistry.

TOPIC: Organic Chemistry

SUB-TOPIC: Conjugation

METHOD: Lecture Method

BEH. OBJECTIVES: By the end of the lesson students should be able to define, explain and give examples of different types of organic compounds with conjugated bonding e.g. Alkenes; 1, 3 – butadiene. Aromatic compounds; Benzene, Anthracene, etc.

INTRODUCTION: The lesson will begin through the following questions, based on their previous knowledge:

i) Name the four classes of Hydrocarbons,
ii) Alkenes are unsaturated. Why?,
iii) What is conjugation?.

PRESENTATION: The teacher presents the lesson through the following steps;

STEP I: The teacher explains the meaning of conjugation to the students in relation to the formation of double bonds in hydrocarbon compounds e.g. conjugation is the existence or the occurrence of double bonds in alternating form, which can leads to the formation of Aromatic compounds due to Aromaticity. Etc.

STEP II: In this the different form of double bonds are explained by the teacher e.g.

i) Cumulative form
ii) Isolated form
iii) Conjugated form

STEP III: The characteristic features of conjugated double bonds in Hydrocarbon compounds are later explained

STEP IV: This involved summary, conclusions and evaluation. The teacher summarized all and conclude the lesson by given the students assignment. Evaluation is done through questions and answers verbally by both the teacher and the students.

APPENDIX VIe

WEEK III **Lesson plan III: for experimental group**

SUBJECT: Chemistry

CLASS: NCE II Chemistry.

TOPIC: Organic Chemistry

SUB-TOPIC: Delocalization

INST. MATERIALS: Computer set, CD Plate, Projector with screen.

METHOD: Demonstration Method

BEH. OBJECTIVE: By the end of the lesson the students should be able to describe the term Delocalization, give examples of compounds with delocalized electrons and its relationship to Aromatic compounds.

INTRODUCTION: The teacher introduces the lesson by asking questions that are related to the students' previous knowledge e.g.

i) What are the postulates of the molecular orbital theory?
ii) Identify the different forms of energy level?
iii) How many double bonds and single bonds are found in Benzene ring?

PRESENTATION: The lesson is presented through the following steps,

STEP I: This involved brief explanation of the term delocalization and its relationship to Aromaticity, the benzene structures is used to exemplify the occurrence of delocalization in the ring structures of all Aromatic compounds.

STEP II: Computer set is used to view the delocalization of Pi electrons in Aromatic structures e.g. benzene ring (Appendix VIc). A projector can be used to enlarge the illustrated structures for the purpose of large class viewing

STEP III: Other examples of delocalization are given using the same instructional materials e.g. Naphthalene, phenanthrene, Cyclopentadienide, etc (Appendix VId). This is done to enable the students realized that delocalization can occur in any Aromatic compound not necessarily benzene.

STEP IV: This involve students activity, to demonstrate the concept of delocalization based on their ability to use any of the instructional materials mentioned in this report.

STEP V: This involves the summary, conclusion and evaluation of the lesson. In this students are allowed to express their opinion about the concept of delocalization and to answer questions on the said concept.

APPENDIX VIf

WEEK III **Lesson plan III: for control group**

SUBJECT: Chemistry

CLASS: NCE II Chemistry.

TOPIC: Organic Chemistry

SUB-TOPIC: Delocalization

METOD: Lecture Method

BEH. OBJECTIVE: By the end of the lesson the students should be able to describe the term Delocalization, give examples of compounds with delocalized electrons and its relationship to Aromatic compounds.

INTRODUCTION: The teacher introduces the lesson by asking questions that are related to the students' previous knowledge e.g.

iv) What are the postulates of the molecular orbital theory?
v) Identify the different forms of energy level?
vi) How many double bonds and single bonds are found in Benzene ring?

PRESENTATION: The lesson is presented through the following steps,

STEP I: This involved brief definition of the term delocalization and its relationship to Aromaticity, the benzene structures are used to exemplify the occurrence of delocalization in the ring structures of all Aromatic compounds.

STEP II: The teacher further explains verbally, the concept of delocalization as it relates to resonance and Aromaticity e.g. delocalization is the existence of Pi-electrons in resonating form and that could lead the formation of ring of Pi-electrons, which in turn results to Aromaticity.

STEP III: The lesson is concluded and summarized by giving examples of structures or compounds having delocalized electrons. (e.g. Appendix Vic).

STEP IV: The lesson is evaluated by asking questions like, define or explain the term delocalization, give examples etc. (as stated in the behavioral objective).

APPENDIX VIg

WEEK IV **Lesson plan IV: for Experimental group**

SUBJECT: Chemistry

CLASS: NCE II Chemistry.

TOPIC: Organic Chemistry

SUB-TOPIC: Hybridization

INST. MATERIALS: Computer set, CD Plate, Projector with screen.

METHOD: Demonstration Method

BEH. OBJECTIVE: By the end of the lesson the students should be able to describe the term Hybridization, give some examples of compounds formed by Hybridized orbitals.

INTRODUCTION: The teacher introduces the lesson by asking questions on the uniqueness of carbon, e.g.

i) What is the ground state of Carbon?
ii) What is the excited state of Carbon?
iii) Explain the tetravalency of Carbon,
iv) Explain the energy level of p-orbitals in Carbon atom.

PRESENTATION: The teacher presents the lesson through the following steps;

STEP I: Solutions to the above questions given and discussed by the students under the guidance of their teacher. In this, molecular model are used to verify any misconception held by the students.

STEP II: This involved the use of computer to vividly show and demonstrate the existence of hybridization in the configuration of Carbon atom (refer appendix VIIc), e.g.

i) SP^3 – Hybridization
ii) SP^2 – Hybridization
iii) SP - Hybridization

STEP III:	At this step, students are allowed to explain their observations from the demonstrated concepts. This enables the teacher to identify their misconceptions and to remedy them.
STEP IV:	This includes conclusion, summary and evaluation of the lesson. A summary of the demonstrated concept are given and the lesson is evaluated by asking questions and allowing the students to give varying examples of the said concept.

APPENDIX VIh

WEEK IV Lesson plan IV: for Control group

SUBJECT: Chemistry

CLASS: NCE II Chemistry.

TOPIC: Organic Chemistry

SUB-TOPIC: Hybridization

METHOD: Lecture Method

BEH. OBJECTIVE: By the end of the lesson the students should be able to describe the term Hybridization, give some examples of compounds formed by Hybridized orbitals.

INTRODUCTION: The teacher introduces the lesson by asking questions on the uniqueness of carbon, e.g. i) what is the ground state of Carbon?

ii) What is the excited state of Carbon?
iii) Explain the tetravalency of Carbon,
iv) Explain the energy level of p-orbitals in Carbon atom.

PRESENTATION: The teacher presents the lesson through the following steps;

STEP I: Giving answers to the above questions to enhance the development the lesson i.e. using the previous knowledge of the students.

STEP II: detail explanation of the concept "Hybridization" is given to students using the talk and chalk method e.g. Hybridization is the concept of mixing atomic orbitals to form new hybrid orbitals suitable for the qualitative description of atomic bonding properties. Hybridized orbitals are very useful in the explanation of the shape of molecular orbitals for molecules. It is an integral part of the valence shell electron-pair repulsion (VSEPR) theory……… Theorized by chemist Linus Pauling (1981).

STEP III: This involve further explanations on the concept and examples of compounds formed by hybridized orbitals

STEP IV: This includes conclusion, summary and evaluation. The lesson is concluded by summarizing all that has been said and questions are thrown to students, based on the concept taught. Students are also allowed to ask questions, if any and finally assignments for further studies are given to the students.

APPENDIX VIi

WEEK V **Lesson plan IV: for Experimental group**

SUBJECT: Chemistry

CLASS: NCE II Chemistry.

TOPIC: Organic Chemistry

SUB-TOPIC: Isomerism

INST. MATERIALS: Organic Chemistry Molecular Models

METHOD: Demonstration Method

BEH. OBJECTIVE: By the end of the lesson, students should be able to define and explain the concept of Isomerism. Identify the various types of isomerism and give examples.

INTRODUCTION: the lesson is introduced to the students by presenting the models and its uses e.g. construction of compounds like;

i) Dichloroethene
ii) 2, 3-dimethylbutene. Etc.

PRESENTATION: The lesson is presented through the following steps;

STEP I: The concept of isomerism is presented to the students inform of; phenomenon whereby certain compounds, with the same molecular formula, exist in different forms owing to their different organization of atoms. In other words, Isomerism occurs when two or more compounds have the same molecular formula but at least two different physical or chemical properties due to some structural or spatial difference in molecular structure …………

STEP II: In this step, molecular models are used to demonstrate the concepts of isomerism, types, examples etc.

a) Structural isomerism – isomers having different structures
b) Stereoisomerism – isomers having the same structure and bond sequence but different in atomic orientation in space
c) Geometric isomerism – this involves double bond that does not allow free rotations

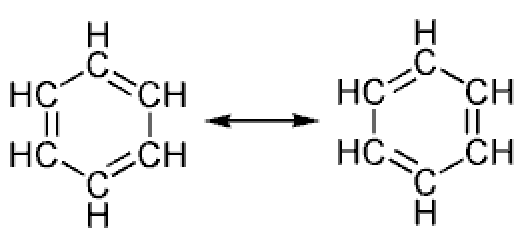
APPENDIX VIIa

Organic Chemistry Molecular Models (Hydrocarbons)

THESE ARE USED TO EXPLAIN SCIENTIFIC CONCEPTS/PROCESSES;

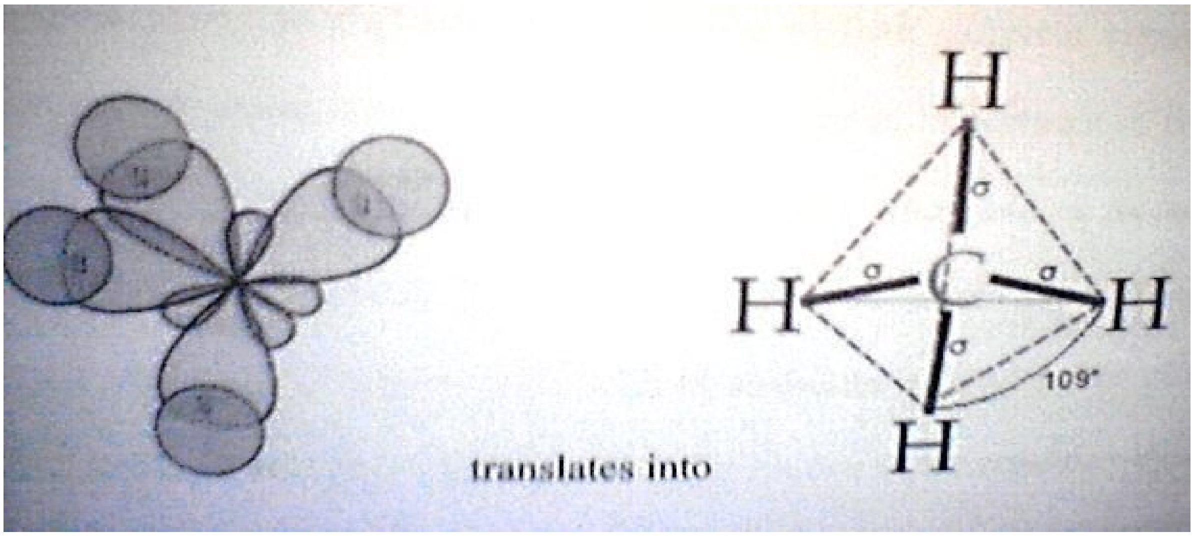
- Construct homologous series of hydrocarbons
- Understand how certain elements can combine to form organic compounds
- Demonstrate single and double bonding between atoms

This Lab-Aid allows students to construct the homologous series of hydrocarbons, such as alkanes, alkenes, alkynes and benzene.

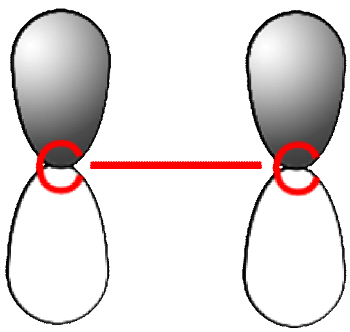


APPENDIX VIIb

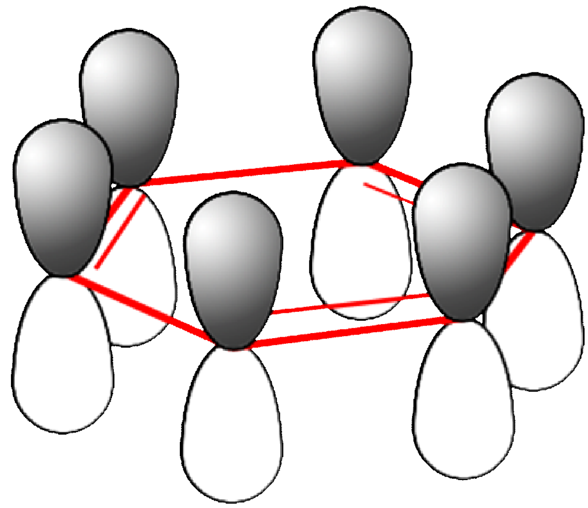
APPPENDIX VIIc



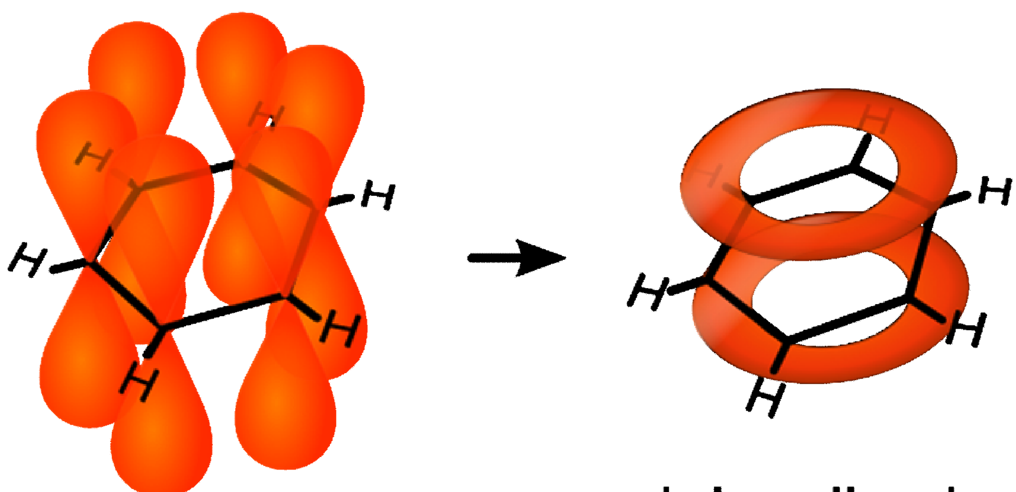
APPPENDIX VIId



Side view



Projection

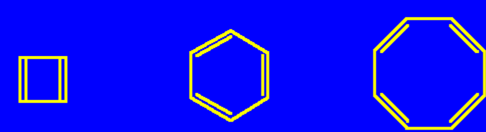


6 p-orbitals delocalized

Appendix vIIe. Aromaticity

Requirements for Aromaticity

cyclic conjugation is necessary, *but not sufficient*

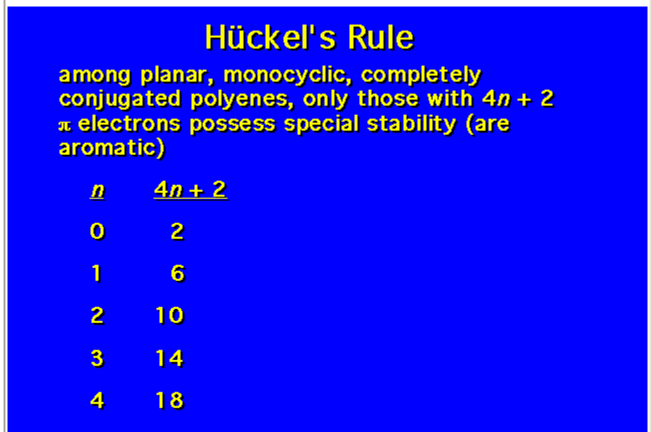


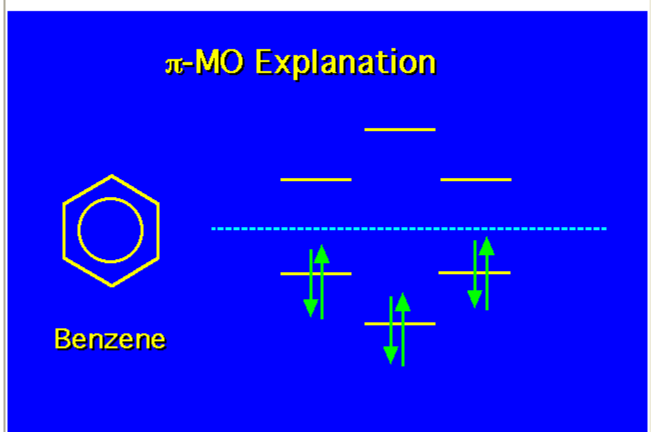
not aromatic	aromatic	not aromatic

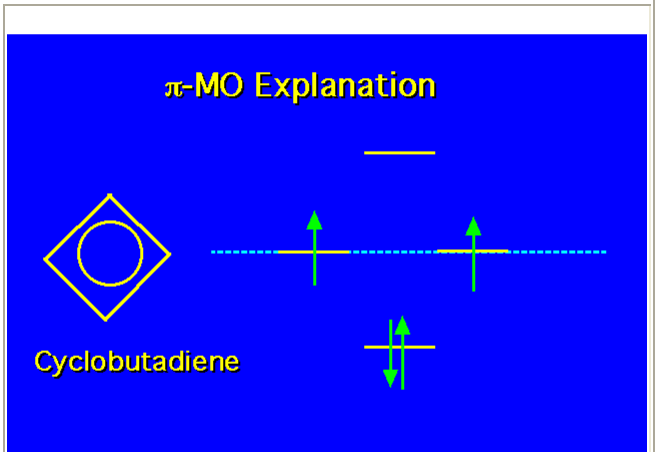
Structure

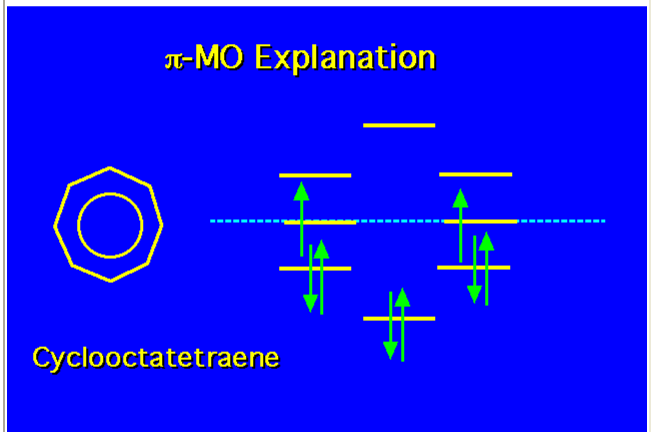
cyclobutadiene is rectangular, not square

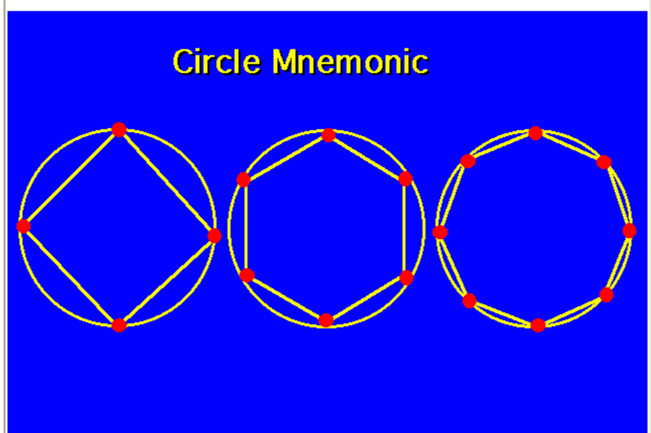
cyclooctatetraene is not planar

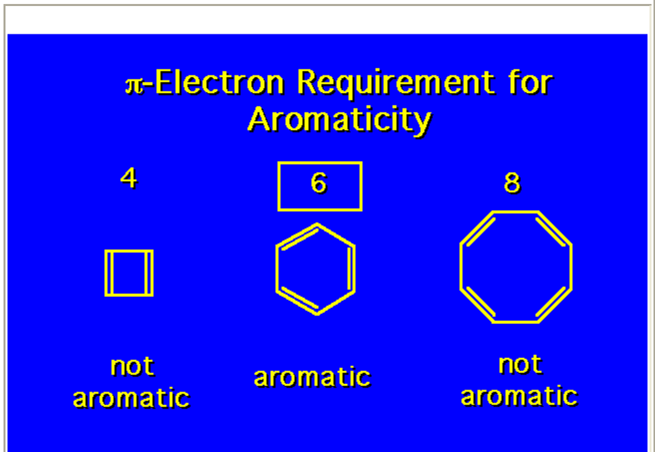

Hückel's Rule
among planar, monocyclic, completely conjugated polyenes, only those with 4n + 2 π electrons possess special stability (are aromatic)
n 4n + 2
0 2
1 6
2 10
3 14
4 18

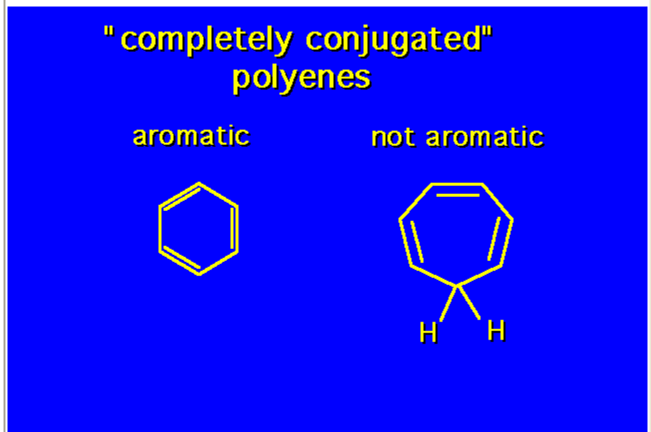

π-MO Explanation
Benzene

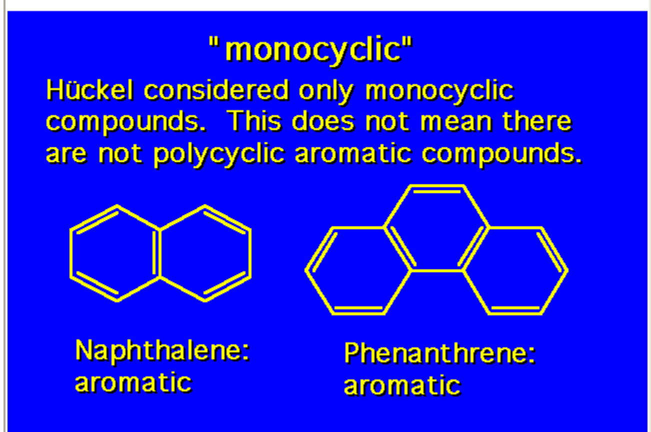

π-MO Explanation
Cyclobutadiene

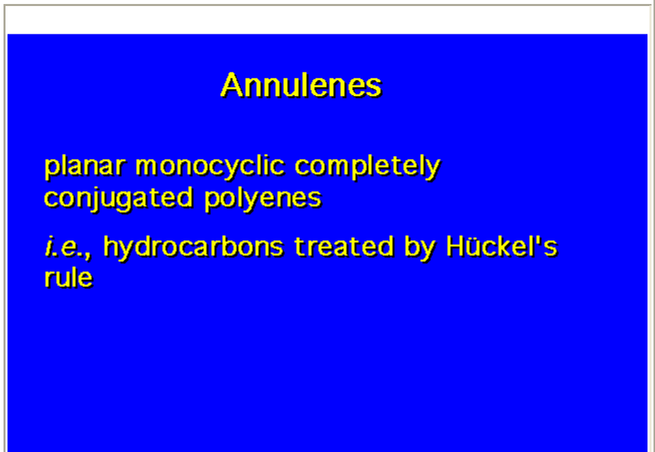

π-MO Explanation
Cyclooctatetraene

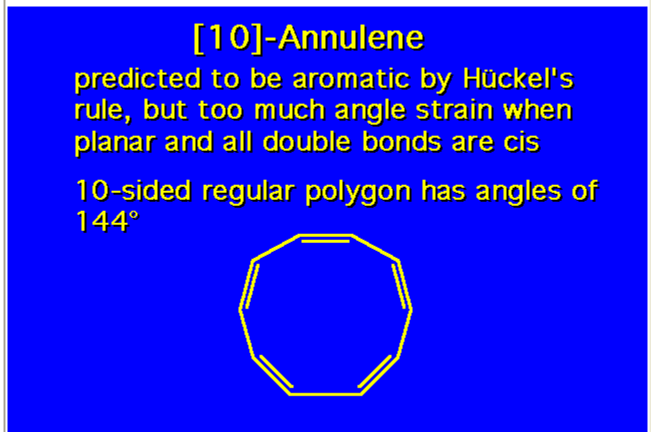

Circle Mnemonic

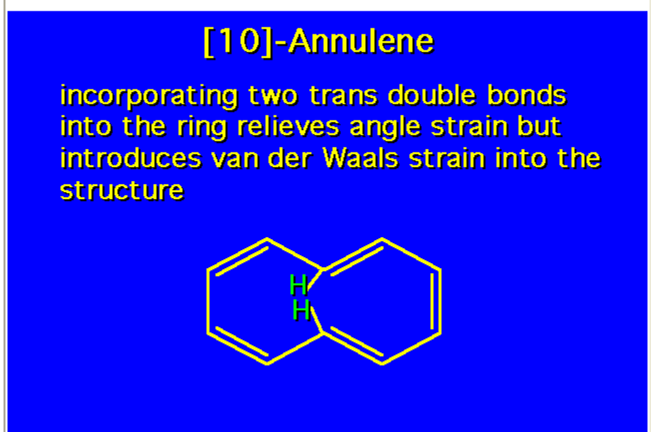

π-Electron Requirement for Aromaticity
4
6
8
not aromatic
aromatic
not aromatic

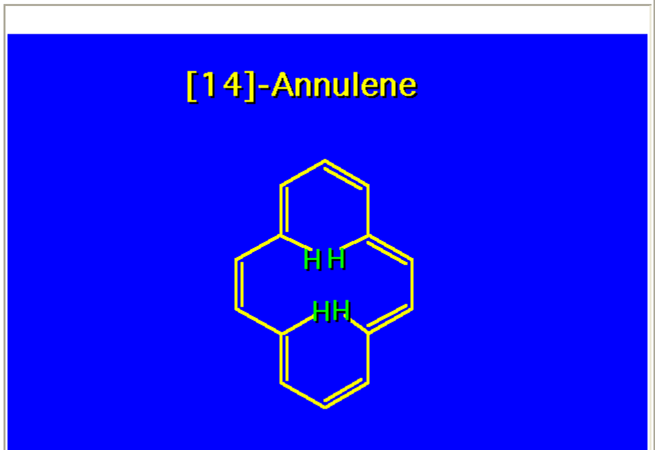

"completely conjugated"
polyenes
aromatic
not aromatic
H
H

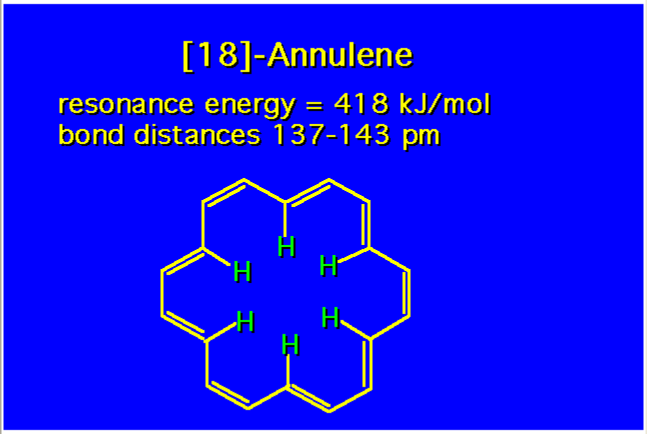

"monocyclic"
Hückel considered only monocyclic compounds. This does not mean there are not polycyclic aromatic compounds.
Naphthalene:
aromatic
Phenanthrene:
aromatic

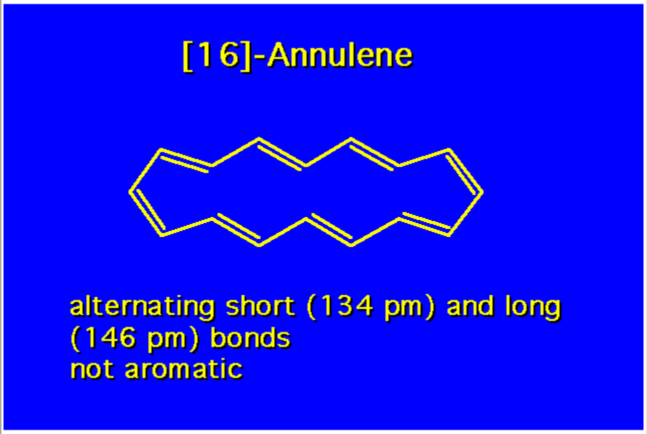

Annulenes
planar monocyclic completely conjugated polyenes
i.e., hydrocarbons treated by Hückel's rule

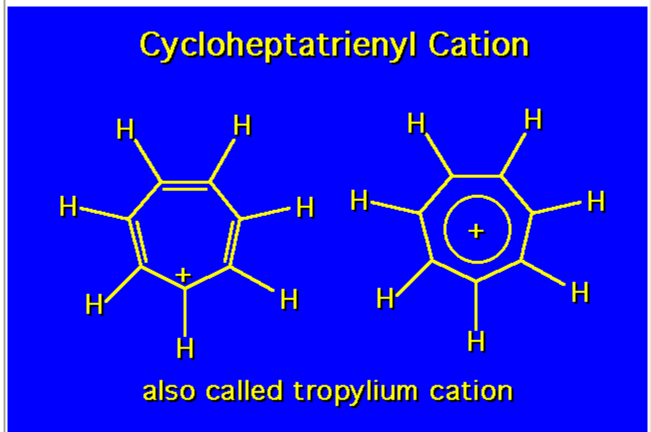
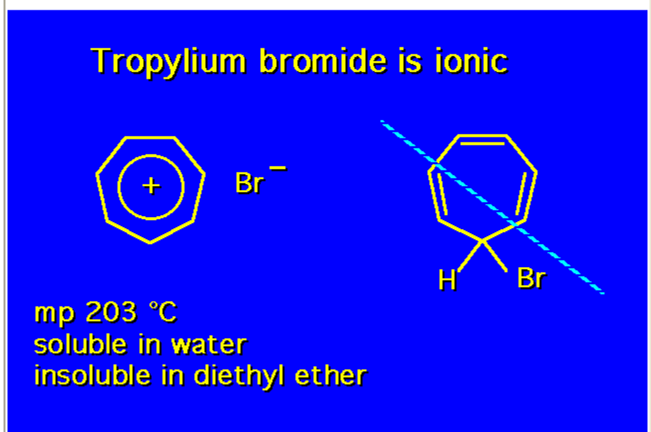
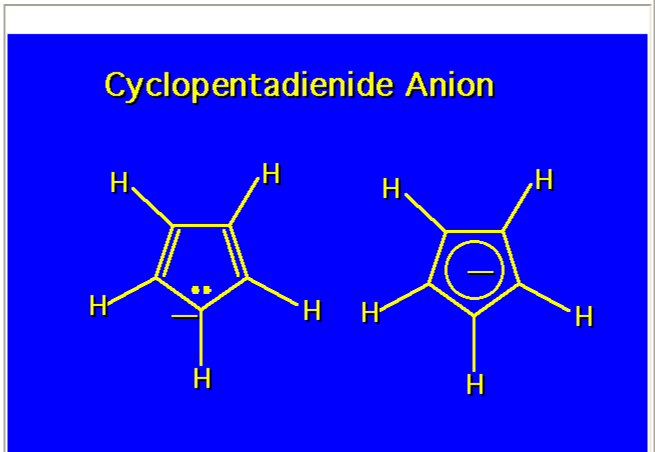

[10]-Annulene
predicted to be aromatic by Hückel's rule, but too much angle strain when planar and all double bonds are cis
10-sided regular polygon has angles of 144°

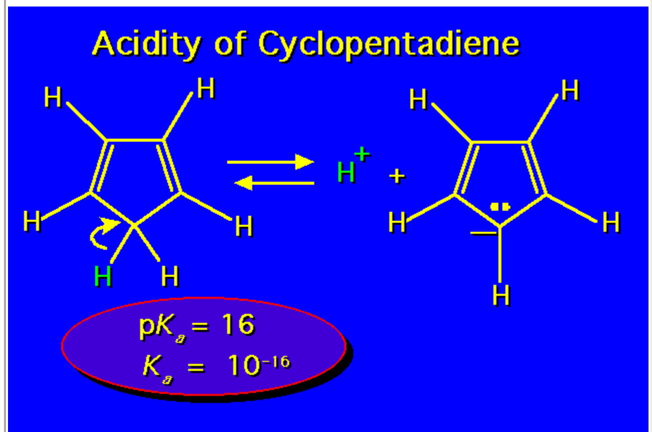

[10]-Annulene
incorporating two trans double bonds into the ring relieves angle strain but introduces van der Waals strain into the structure
H
H

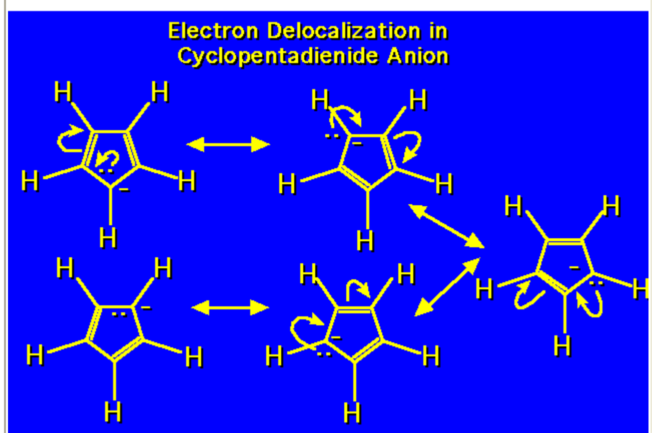

[14]-Annulene
H H
HH

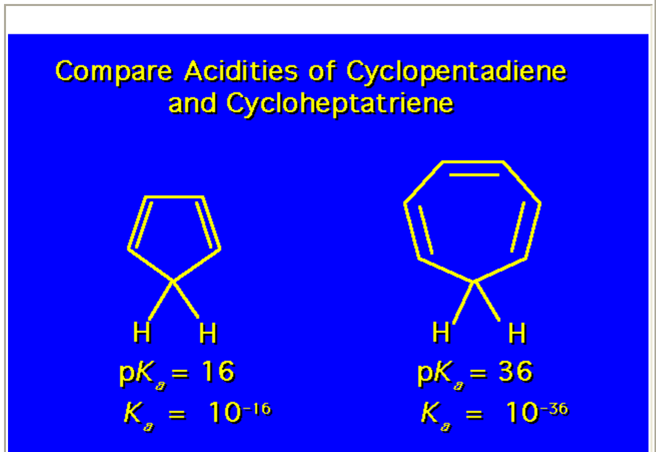

[18]-Annulene
resonance energy = 418 kJ/mol
bond distances 137-143 pm
H
H
H
H
H
H

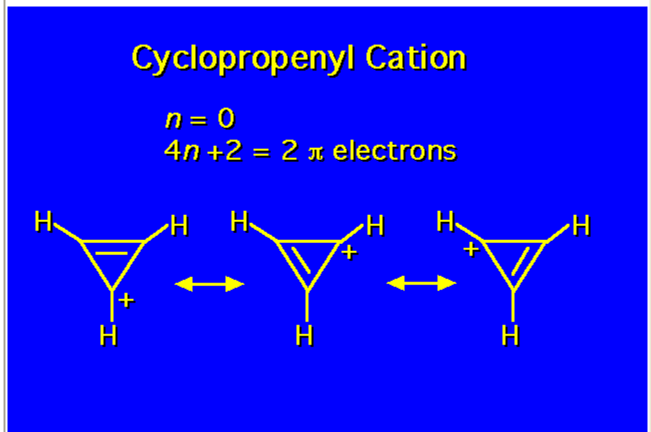

[16]-Annulene
alternating short (134 pm) and long
(146 pm) bonds
not aromatic

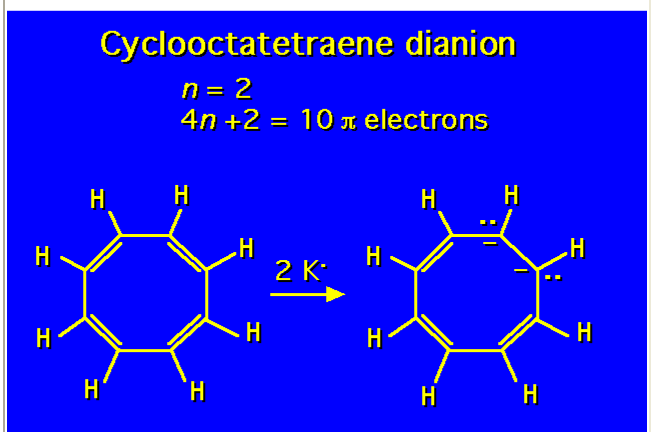
	Cycloheptatrienyl Cation also called tropylium cation
	Tropylium bromide is ionic Br H Br mp 203 °C soluble in water insoluble in diethyl ether
	Cyclopentadienide Anion


Acidity of Cyclopentadiene
pKa = 16
Ka = 10-16


Electron Delocalization in
Cyclopentadienide Anion


Compare Acidities of Cyclopentadiene
and Cycloheptatriene
pKa = 16
Ka = 10-16
pKa = 36
Ka = 10-36


Cyclopropenyl Cation
n = 0
4n +2 = 2 π electrons


Cyclooctatetraene dianion
n = 2
4n +2 = 10 π electrons
2 K·