CHAPTER ONE

INTRODUCTION

Background to the study

Everybody in the society today feels the impact of science and technology. Science has permeated the life and daily activities of man to the extent that man's life can hardly be sustained without it. The advancement of science and technology is greatly governed by its application to societal needs and aspirations. The role of science and technology encompasses political, social, medical, economic, education and so on. Science and economy provide new and fast routes to economic growth. They are used in establishing the global position of a nation. Thus, the super powers, the developing and under-developed nations are classified based on their levels of scientific and technological advancement. This is with respect to their military might, economic power, industrial development and level of agricultural mechanization. The aforementioned indices of scientific and technological advancement require chemistry as a core discipline. This may be among the reasons why the Federal Government of Nigeria in the NPE (2013, Revised) included chemistry as one of the science subjects offered in the senior secondary school. Also, chemistry is a critical determinant of the post secondary education and career options available to young people in the sciences (Ezeliora, 2005, Nnaka, 2010).

Stressing the importance of chemistry, Ezeliora (2009) described the subject as the mirror of civilization in all the centuries of development and the most basic discipline for any person who would be truly educated in any science and in many other endeavours. Ezekannagha and Ifeakor (2005) also pointed out that the functional role of chemistry in science and technology is so many that no area of science, technology and business enterprise escapes its application. Despite the importance placed on chemistry, it is very disappointing to note that students' performance in the subject at both internal and external examinations has remained consistently poor (Udo & Eshiet, 2007; Igboegwu, 2006; Udobia, 2002). Reports show that mass failure in chemistry examination is real and the trend of students' performance has been on the decline (Aliyu, 2000; Udofia 2008 & Olayiwda, 2006). However, many variables that could be responsible for the poor performance of students in chemistry have been identified by Uduchukwu(2008). Such variables include government, curriculum, examination bodies, teachers, students, home and textbook. The government failed to recruit more qualified chemistry teachers with a teacher: student ratio of 1:80 to handle chemistry and this has failed to address the proper application of chemistry in everyday life (Okebukola, 2005). Apart from this problem, some other variables have been identified to include: poor primary school background in basic science, lack of interest on the part of students, lack of incentives for the teachers, incompetent teachers in primary schools, students' lack of interest, and large class syndrome (Akpan, 2008). Other variables according to Igboegwu,

(2010) include: poor conditions of service for teachers, poorly equipped laboratories and teachers' late commencement of the practical aspect of chemistry.

Poor performance in chemistry which also emanates from anxiety and phobia has been observed by Aprebo (2002) to be an academic problem which has not yet been fully diagnosed for effective treatment. These anxiety and phobia are usually expressed on the faces of chemistry students in their classes because of a number of learning difficulties they are passing through. Aprebo further pointed out that the negative effect of the anxiety and phobia is spread to all other subjects that relate to chemistry. The West African Examinations Council (WAEC) Chief Examiner's Report (2010) suggested that students' performance in chemistry could be improved through meaningful and proper teaching. According to the report, teachers should reduce the abstractness of chemistry, control the apathy and fear of the subject, and enhance the interest and achievement of students.

Organic and inorganic substances form major components of our chemical environment. Although organic substances such as sugar, starch, alcohol, resins, oil, indigo and others have been known from the earliest times, very little progress in their chemistry was made until about the beginning of the eighteenth century (Finar,2008). The works of Lemery in 1676, and Lavoisier in 1784 led to the classification of substances that were produced by the living organisms as

organic, and all those ones which were not prepared from living organisms as inorganic (Finar, 2008).

From the works of Priestly in 1681, Cavendish in 1785, and Scheele in1783; Partington in 1960 further pointed out that organic chemistry is the chemistry of the carbon compounds (Finar,2008). However, Finar remarked that the differences between the two classes of compounds have been disproved, and described organic chemistry as application of fundamental principles which consist of a large variety of methods and reactions. In recent times, these reactions have not been properly presented to the learners for proper understanding. As a result, there is still the need to find some effective ways of instruction like the concept mapping and simulation game strategies.

Simulation game is a type of advanced organizer learning strategy advocated by Ausubel in 1962. Onwioduokit and Akinbola (2005) described advance organizer learning strategy as a pedagogic strategy for implementing the programme principles of progressive differentiation and integrative reconciliation which involves appropriately linking the known with unknown. It is used to provide conceptual framework which students can use to clarify the task ahead. Advanced organizer enhances meaningful learning because it is a strategy in which the teacher helps students to make connections to new material by highlighting the organizational and structural patterns of the new material and indicating how it relates to other materials already known (Coffey, 2000)

Simulation represents a reality within which students interact while the teacher controls the parameters of this world and also uses it to achieve the desired instructional results. The simulation game helps learners to develop the skills for collecting and organizing information and enables them accept others' viewpoint without any bias. It also helps learners to retain what they have learned for a long time because as a game, it involves the active participation of students, and the material being learned has greater chances of being integrated into learners' cognitive structure (Okebukola, 2005).

Concept mapping is a model of instructional strategy developed by Novak and his associates at Cornell University in the early 70's (Ahove, 2001). It is a meta-cognitive learning technique for assisting learners to organize information about concepts in a meaningful manner in order to facilitate meaningful learning. Ahove stated that concept mapping strategy is hinged on the fact that concepts do not exist in isolation but rather are inter-related with others to make meaning. The organization of new concepts that are inter-related helps the learner to make mental connections between these ideas. This teaching strategy was developed from Ausubel's assimilation theory of cognitive learning which states that the new concepts are acquired through assimilation into existing cognitive propositional framework (Ahove, 2001). Ausubel's idea of hierarchical presentation of concepts was later described as cognitive maps or concept maps.

Concept mapping and simulation game are problem-solving, activity-oriented approaches to learning which offer learners the opportunity to participate and be actively involved in the whole process of teaching and learning. However, while concept-mapping is a graphical or diagrammatical representation indicating interrelationship among concepts, the simulation game is a form of experiential learning and instructional scenarios which represent reality within which students interact and gather knowledge. Both concept-mapping and simulation game strategies are activity oriented.

Focusing on the interest and achievements of the learner, Akinsola (2002), lamented that education has been concerned with cognitive learning, mainly at the expense of the affective and psychomotor aspects. Imoko(2004) described interest as one practical class of attitudes, are associated with objectives or activities that are needed for satisfying and pleasure giving.

Indeed for the development of positive attitudes to chemistry, there is the need to sustain students' interest in such scientific problems and educational issues. Also the tendency to seek out and participate in certain kinds of activities in preference to others is a hallmark of interest. Cueing from the fact that interest is an emotionally oriented vocational trait which to great extent affects the vocational choice of students (Igboegwu, 2005), it follows that students are bound to pay attention as the lesson progresses if that particular lesson and the teacher's method of teaching are interesting to them. There arises the need for teaching methods that would motivate, arouse and sustain the interest of the students in particular subjects. Therefore, interest as a factor in learning was among the central concepts in this study.

Gender which constitutes those characteristics that distinguish the male from the female was described by Nworgu (2005) as certain characteristics of men and women which are culturally and socially determined. Those that are biologically determined are regarded as sex. Ifeakor (2005) and Otubah (2007) reported that males show prevalence of significant gender differences in achievement and interest of the students in the sciences with particular reference to organic chemistry. This gender disparity has been attributed to factors which include the teaching strategies, economic, cultural, social, political and religious beliefs (Isa, 2005 ; Nworgu, 2005).

Nzewi (2001), expressing the prowess of women, referred to them as managers and the custodians of the managers. Nworgu (2005) summarizing gender issues in science said that science is everywhere and everyone can do science and advocated the need for science teachers to understand the importance of using gender equitable instructional strategies in science classroom environment. Such instructional strategies could reduce gender gap on achievement and interest. It is on this basis that gender and its effect on achievement and interest were determined.

Since the tendency to select and participate in certain kinds of activity is a hall mark of interest, students are bound to pay attention as a lesson progresses if the material and the teacher’s method are interesting to them. As chemistry is the mirror of civilization and a core subject in science and technology, and organic chemistry central to many industrial processes, learners are expected to acquire

skills and attitudes that are needed to apply chemical concepts. Teaching method could be an important factor in propagating these skills. Therefore, there is the need to study the relative effectiveness of concept mapping and simulation game as innovative methods of teaching chemistry to arouse and sustain the interest of students in organic chemistry for improved performance.

Statement of the Problem

The world experiences influxes of initiatives and innovations in a bid to cope with emerging challenges(Okeke,2012). These initiatives and innovations are determined by the capacity of every nation in the professional sciences which includes chemistry. Chemistry which is an important science subject in the school curriculum is central to the study of many professional sciences and science-based courses in the institutions of higher learning. Such courses include the medical sciences, agricultural science, biological science, engineering and technology. Unfortunately not many students in the secondary schools study chemistry(Asiyai,2015). They adduce diverse reasons for being scared of this all-important subject. Among the few who study it, achievement is generally low. Various reasons have been adduced for this unwholesome poor achievement and undesirable lack of students' interest in the study of the subject. This includes faulty and inappropriate teaching methods. Udo and Eshiet (2007) attributed students' lack of interest in chemistry to the traditional teacher centered lecture method mostly used by the teachers. Furthermore, researchers (Okebukola 2005, Udo 2007, Njoku 2008 & Igboegwu, 2010), point

to the fact that the current method of teaching science (chemistry) may not be exciting to the students, and the end result are students' lack of interest and low achievement as learners would predictably do well in their areas of interest.

The case of organic chemistry is particularly worrisome. Much as it is central to manufacturing and industrial processes for diverse products of human need. The attitude of teachers and students to organic chemistry is often unbecoming. Teachers are scared of venturing into it and students much more than teachers are scared of reading it. The structures and nomenclatures of organic compounds may not be the only reason. Indeed, it is a compelling necessity that effective strategies of enhancing interest and achievement in this discipline be evolved. Some of such strategies may be the use of appropriate or innovative instructional strategy. Examples of such desirable strategies include concept mapping and simulation game. Accordingly, the first and fundamental problem of this study is to ascertain the relative effectiveness of concept mapping and the simulation game on the interest and achievement of students' in organic chemistry.

Purpose of the Study

The main purpose of this study was to determine the relative effectiveness of concept mapping and simulation game on the interest and achievement of students in organic chemistry. Specifically, the study was designed to:

i. find out if the interest and achievement of students in organic chemistry would be improved when taught with concept mapping and simulation game instructional strategies.

ii. find the difference in the interest and achievement of the students when taught organic chemistry using concept-mapping and simulation-game.

iii. find out the difference in the effect of simulation game and concept mapping on the interest and achievement of students in organic chemistry.

iv. find out the interaction effect of gender and teaching methods on the interest and achievement of students in organic chemistry.

Significance of the Study

The effect of instructional strategies on interest and achievement of students will help the teachers in the proper implementation of the curriculum. Also the two strategies could help the teacher in entry-behaviour testing, introducing novel concepts, teaching difficult concepts and making provision for active involvement of the learners.

Use of concept-mapping and simulation game in the chemistry classroom will enhance the students' understanding of the concepts so that they can apply and even transfer the knowledge acquired in their day-to-day living. The study will help secondary school students to eliminate some of their social apathy towards chemistry and realize that their achievement depends on their own active participation and not on their teachers alone.

The effectiveness of concept-maps and simulation game teaching will help the curriculum planners to recommend such desirable strategies when reviewing chemistry curriculum. Also the goals of the curriculum planners will be re-directed towards acquisition of performance skills in chemistry than just acquisition of knowledge.

It is expected that this study would be of help to chemistry text writers in designing activities involving the simulation game instructional strategy. In this way, the teachers will use it when found in the teachers' guide to improve their knowledge of the strategy.

Finally, the society will benefit from the study because it will help to enhance students' interest in chemistry. Also the subject and its allied disciplines (engineering, pharmacy, industrial physics, etc) will experience increased enrolment of students in our institutions of higher learning. If students study chemistry and its allied disciplines, the dream of achieving a high technological society will be fully realized.

Scope of the Study

The study focused on the relative effectiveness of two teaching strategies (concept-mapping and simulation game) on the interest and achievement of senior secondary three chemistry students. It also surveyed how the two teaching strategies are reflected on the gender of the students. More so, the content of the teaching strategies covers two major units in the senior secondary school organic chemistry syllabus namely: esterification and saponification. These topics are

justified by the fact that they could be used to demonstrate these two strategies. They will provide enough activities to arouse the interest of the student.

The study covered all the senior secondary three students in the Ogidi Education Zone of Anambra State.

Research questions

1. What is the difference between the mean gain interest scores of male and female students?
2. What is the difference between the students taught with simulation game and concept mapping instructional strategies as measured by their mean gain interest scores?
3. What is the difference between the students taught with simulation game and concept mapping as measured by their mean gain achievement scores?
4. What is the difference between the mean gain achievement scores of male and female students?
5. What is the difference between the students taught with simulation game and concept mapping as measured by their mean gain achievement scores?
6. What is the difference between the mean gain achievement scores of male and female chemistry students taught with simulation game concept mapping instructional strategies?

Hypotheses:

1. There is no significant difference in the mean gain chemistry interest scores of students taught with simulation game and concept mapping instructional strategies.
2. There is no significant difference in the mean gain chemistry interest scores of male and female students.
3. There is no significant interaction effect of teaching method and gender on their mean gain chemistry interest scores.
4. There is no significant difference in the mean gain achievement scores of students taught with simulation game and concept mapping instructional strategies.
5. There is no significant difference in the mean gain chemistry achievement scores of male and female students.
6. There is no significant interaction effect of teaching method and gender on their mean gain chemistry achievement scores.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

The literature review is organized under the following headings:

Conceptual Framework

Concept Map

Simulation

Interest

Achievement

Theoretical Framework

Jerome Brunner's Theory Of Cognitive Development

David Ausubel's Subsumption Theory of Meaningful Learning

Gagne's Conditions of Learning Theory

Theoretical Studies

The Role of Chemistry and the Importance in Teaching and Learning

Instructional Strategies for Teaching Chemistry.

Learning, Concept Mapping and Simulation Game Approach

Interest as a Factor in Learning

Gender as a Factor on Interest and Achievement of Student.

Location as a Factor in Cognitive Achievement and Interest

Empirical Studies

Studies on Concept Mapping

Studies on Simulation Game

CONCEPTUAL FRAMEWORK

Concept Map

Concept map as defined by Novak and Godwin (1984) is a schematic device for representing a set of concept meanings embedded in a framework of prepositions. Webster's New Collegiate Dictionary, 150th Anniversary Edition defines a concept as something conceived to the mind: thought, notion: an abstraction or generic idea generalized from particular instance" while a map "is a kind of visual network showing some of the pathways we may take to connect things. Asiyai (2005) defines maps as diagrammatical representation of geographical regions and these maps help to show one's bearing thus helping one to proceed to ones destination. In relating the two terms, Asiyai (2005) went further to define concept mapping as a graphical arrangement of key concepts to show meaningful relationship among the selected concepts or ideas being studied. To Inomesia and Umuero (2003), it is a structural, visual means of representing concepts and their relationships.

Concept maps, according to Novak (1990) are diagrams indicating inter-relationships among concepts as representation of meanings or identical framework specific to a domain of knowledge.

Concept-map is a Meta cognitive tool developed by Novak and a team of researchers from the Cornell University in 1972 (Kola-Olusanya,1998). According to kola-Olusanya (1998), this learning strategy was first developed as a research tool to represent learners' prior, relevant knowledge and later as a tool to enhance meaningful learning. The development of the strategy was based on Asubel's theory of meaningful learning which is based on the principle that the single and most important factor influencing learning is what the learner already knows. It relates directly to such theoretical principles as prior knowledge, consumption, progressive differentiation, Cognitive bridging and integrative reconciliation (Canasl 2003, Okebukola ,1997). Udeani (2000) saw concept mapping as one instructional strategy which allows the theoretical ideas of Piaget & Ausubel to be implemented by teachers. The efforts in assisting the learners to learn led to the development of this meta-cognitive strategy to enhance meaningful learning. Meta-cognitive strategies, Akinola and Igwe (2007) explained, are strategies that empower the learner to take charge of his or her own learning in a highly meaningful fashion. The fundamental idea in Ausubel's cognitive theory is that learning takes place by the assimilation of new concepts and prepositions unto existing concepts and prepositional structures or framework held by the learner. This knowledge structure already held by a learner is also referred to as the individual's cognitive structure (Feltovieh, 1993).

One of the most fundamental goals in the use of concept maps is to foster meaningful learning and according to Ausubel (1963) as cited in Canas (2003) must meet the following conditions:

Firstly, the material to be learned must be conceptually clear and presented with language and examples relatable to the learners prior knowledge. Concept maps can be helpful in meeting this condition both by identifying general concepts prior to instruction in more specific concepts and by assisting in the sequencing of learning tasks into developing conceptual frameworks. Secondly, the learner must possess relevant prior knowledge which keys in the advanced organizer. Thirdly, the learners must choose to learn meaningfully. The one condition over which the teacher or mentor has only indirect control is the motivation of students to choose to learn by attempting to incorporate new meanings into their knowledge, other than supply memorizing concept definitions or propositional statements or conceptual procedures. The creation of concept maps supports the incorporation of meanings into prior knowledge. Concepts are usually enclosed in circles or boxes and the relationship between and among concepts are indicated using “Cross-links” or connecting lines that link them together. The relationships between the concepts are articulated in linking phrases or words on the connecting lines, example, “gives rise to”, ’’result in”, is required by “or “contributes to etc. In addition, in concept mapping the concepts are arranged and presented in a hierarchical order, with the most inclusive, most general concepts at the top of the map and the less

general, more specific concepts arranged below (Asiyai, 2005). Basic to making a concept map is the ability of the mapper to identify and relate its salient concepts to the general, super-ordinate concept (Okebukola, 1997). Okebukola believed that concept maps can be applied to any subject matter and at any level within the subject.

Concept maps can be constructed from texts or after class discussion/lecture. In constructing concept maps the learner constantly uses new propositions to elaborate concepts that he or she already knows (Inomesia and Unuero, 2003). In other words, learning effect are enhanced, when, in the course of concept mapping (Unuero,1993). Such active, self engaging, transformational interaction with learning material enhances interest and achievement in general.

Concept maps have been put to many uses in education, business and government (Feltovich, 1993). One of the original uses in education was for the assessment of what a learner knows. It can be used to internalize and make explicit the conceptual knowledge (both correct and erroneous) that the students hold in a knowledge domain. It can also foster the learning of well integrated structural knowledge as opposed to the memorization of fragmentary un-integrated facts. Despite the effectiveness of concept mapping in enhancing meaningful learning, its extensive use in the Nigerian class rooms is yet to be established (Udeani, 2000). In a paper presented at the 46th Annual Conference of Science Teachers Association of Nigeria on enhancing chemistry teaching in schools through concept mapping, Asiyai (2005) advised that when chemistry is

taught using concept mapping, the students can easily view at a glance all the concepts in the topics taught. He went further to say that chemistry teachers should make efforts to enable students acquire meaningful learning in chemistry by making the teaching of the subject exciting, purposeful and participatory. Concept mapping strategy seems to be one of the answers to meaningful and purposeful education which appears to have eluded the nation's educational system (Asiyai, 2005). However, like any other tool, the effectiveness of concept mapping depends on how it is used and the conditions in which it is used (Ahove, 2011). This study, therefore, investigated the efficacy of concept mapping in enhancing the acquisition of meaningful learning in organic concepts in chemistry. The effect of this strategy on the students' interest was also determined. This is necessary because if students get interested in organic chemistry, it will go a long way in reducing the ever-growing misconceptions.

Simulation

Another teaching strategy that could influence the acquisition of knowledge and development of interest is simulation game. Simulation, according to the Encyclopedia of Education is:

> "an operating model reproduction or imitation of physical phenomena consisting of a set of interrelated factors or variables which function in essentially the same manner as the actual or hypothetical system" (Encyclopedia of Education 25(196).

In many respects, a simulation is a model of the real world, in which the participants have specific roles to play, make decisions and solve problems according to specified condition. According to Obeka (2007), the word ‘simulation’ comes from the Latin word ‘simili’ which means ‘like’, that is, to act like, to resemble, to pretend to be. Although simulation possesses a high degree of similarity with reality, it is still a reduction and abstraction of reality (Akinsola, 2007). Aliport (1965) in Obeka (2007) appears to be of the same point of view, attitudes, decisions and the resolution of problems.

From the above definitions, it follows, therefore, that simulation is a form of experiential learning and instructional scenario where the learner is placed in a world” defined by the teacher. Simulations represent a reality within which students interact while the teacher controls the parameters of this world and also uses them to achieve the desired instructural results. Furthermore, simulations are, in a way, laboratory experiments where the desired participants/students are the test subjects (Chiel, 2008). The students experience the reality of the scenario and gather meaning from it. The strategy promotes the use of critical and evaluative thinking and since the situation feels real, it leads to a more engaging interaction by learners as well as providing motivating activities which students find enjoyable (Chiel, 2008).

The use of the simulation technique in instruction at different levels has been documented in history and recent literature (Akinsola & Animashun, 2007). While targeting distractions to students, Akinsola(2002) suggested that

teachers should make learning experiential and give students control over their own learning, respect learners' ability to engage in parallel thinking, highlight key and motivate the learner and also provide activities. To heed to these suggestions demand active participation by students in instruction. Therefore, the simulation-game instructional strategy might be a way out since many students enjoy playing games. It then becomes worthwhile to investigate whether this play aspect could be combined with instruction to enhance learning in the organic concepts in chemistry, which is the main focus of his study. The desire is further strengthened by the revelation of Mills et al (1974) as cited in Akinsola and Animashun (2007) that experimentation with realistic simulation-game, the students' great insight that is very difficult to conceptualize by conventional teaching methods would be methodically assisted. Some essential learning/skills inherent in the simulation instructional strategy include:

- Communication: Students must communicate with members of their small group, write up their group results, present group results, discuss questions, invite audience response and also write for assessment.
- Critical and creative thinking: students must analyze, differentiate and discern.
- Personal and social values and skills: students must reflect on the importance of competition and cooperation, learn how to invite members of their group to discuss their ideas as well as the audience and also how to present them to an audience. Students are often more deeply involved

in simulations than other activities because since they are ‘living’ the activity, the opportunity therefore exists for increased engagement. It is therefore hoped that basic organic concepts, can be more deeply appreciated through simulation, hence this study.

Hall (1976) in Umo (2001) regards games and role-play as types of simulation. They may contain elements of game, a role play or activities with special characteristics within the wider context of simulation. Elington (1978) states that by placing pupils in a game simulation they become positively eager to learn. Games usually provide a vehicle whereby pupils can use and develop initiative and power of creative thoughts. They provide the participants with an enjoyable and often memorable experience in the teaching-learning process. In another development, Steinberg (1981) as reported in Akinsola (2007) believes that games enable students to develop positive attitudes and values, relevant knowledge and skills that will aid sustainable existence in this world and to discover and assimilate information. Historically, the word game has been used to connote ‘pastime’ trivial endeavours or fun (Akinsola, 2007). It is this connotation that seems to cause educators to flourish when they hear the word game and imagine frivolous time wasted in play that serves only to entertain and certainly not educate to a significant degree (Akinsola, 2007). He however, added that the use of simulation-games in education is well documented in history and recent literature.

Instructional games as defined by Brown (1977) as in Obeka(2007) are structured activities with set rules for play in which two or more participants interact to reach clearly designated instructional objectives. This implies competitive learning contexts in which participants' success is determined by the degree of subject matter, comprehension of information, concept generalization and theories demonstrated, during game-play. These games require strategy, tactics and initiative from students/participants/players, since they are always competitive. One of the greatest strengths of games as a teaching and learning strategy is in its ability to provide drill and practical applications where students learn in a play-way which removes aversion.

Therefore, while a game is a form of enjoyment and competitive play or sport, bound by rules to achieve specified goals that depended on skill and often involve chance (Okpala, 1991 cited in Obeka, 2007), simulation on the other hand, is a role-play which involves people adopting roles in a mock-up of a situation. In addition, a simulation employs selected aspects of a real-life situation and might not necessarily be competitive, that is, there need not to be a winner, rather a changed condition or situation to be achieved by participants (Akinsola, 2007). Also, a game differs from simulation in so far as the rules of the provide outside constrains with which the participants must reckon. A characteristic feature common to both game and simulation is the use of tactics and strategies from the pupils or participants' initiative. Secondly , in both, the teacher is the coach or referee and therefore, stays uninvolved except he/she

noticed that he/she can facilitate the educational opportunities the exercise presents. Both gaming and simulations are interrelated since both involve the active participation of students in assuming roles, with learning generated by social dialogue and or in decision making towards solving a problem. The boundary between gaming and simulation is so superficial that often times, the two approaches are used interchangeably (Akiweze 1998 in Obeka, 2007). On the other hand, some writers prefer to combine the two terms; 'Simulation Game' to represent instructional games generally (Ughamadu, 1992 in Obeka, 2007). This approach was adopted in this study. Therefore, a simulation game combines the features of a game such as competition, co-operation, rules and players with those of a simulation game such as the critical features of reality (Obeka, 2007, and Akinsola, 2007). Researchers like Akinsola (2007) opined that innovations like games played in the class and outside the classroom improve the mastery of a topic and consequently advised teachers not to limit themselves to the traditional method of teaching. Rather, they should accompany their teaching with innovative systems such as playing games during instructional delivery.

According to Umo (2001), the effectiveness of simulation-games as a teaching and learning strategy depends on the quality of de-briefing which must be well thought out, executed logically with critical and creative thinking abilities. It involves seeking the experiences of the participants as well as passing on the views of the teacher to the participants thereby promoting

experiential learning. It helps in the harmonization of the effects of co-operation and conflicts resulting from the learning experience, Umo (2001) further stated.

The choice of simulation-game strategy for teaching complex, real world situations which change as the students are involved in the activity. Unfortunately, there is evidence that simulation-game is hardly employed by teachers especially in Nigeria despite its numerous advantages (Obeka,2007; Akinsola 2007). A surprising revelation by Aremu (1999) is that most teachers even indicated that the method cannot be used to achieve the objectives of science teachers. In a similar study carried out abroad by Windale, Huddson and Smith (1995), 68% of the 300 secondary school science teachers involved in the study indicated that they never used simulation play as a method of teaching. On the basis of these observations, there is the need to carry out a study to determine the efficacy of simulation play in teaching especially in the teaching and learning of organic chemistry.

Interest

Interest is a persisting tendency to pay attention and enjoy some activity or context, interest promotes learning because very little learning can take place without the learner becoming interested in the subject matter and activities. Though some children may be intellectually and physically capable of learning, they may never learn until their interest is stimulated (Esomonu & Udegbe, 2008). Once the students' are stimulated, they will continue to learn as long as the teacher is capable of sustaining their interest in the subject matter.

Harbor-Peters (2011) also defined interest as a subjective feeling of concentration or curiosity over something. She pointed out that interest can be expressed through simple statements made by individuals of their likes and dislikes and one is likely to do well in a discipline of interest. Interest can be seen also as a mother of attention because once there is direct interest, attention is guaranteed and learning is assured.

Interest is an important variable in learning because when one becomes interested in an activity, one is likely to be more deeply involved in that activity. Njoku(2003) viewed interest as a response of liking and disliking to an event, an activity, an object or a person. It is the degree of likeness an individual has for something such as activity, person or situation. Interest concerns the individual's preference for a particular type of activity. Since preference is involved in it, interest in an activity cannot be absolute. It involves scaling whereby individuals can arrange the activities that are of interest to them in order of preference. The more interesting the activities are, the higher such activities will score on the scale of interest.

Ajelabi (2000) asserted that interest as used in psychological and education measurement is a motivation construct. This implies that interest is an object or activity that is aroused as a result of effort to satisfy a felt need. The individual's need arouses his/her interest or motivates him/her to take action or to participate in activities, having originated from need. Agbakoba(2003) argued that interest and motivation among other variables, are competent of attitude

which can be moderated through reinforcement, learning and experience. Thus a reinforcement or incentive can generate interest or create motivation to participate in certain kinds of activities. Conversely, a negative incentive can be an inhibition which deters interest to participate in certain kinds of activities. This activity may be of interest to students but due to the risks involved, or the fears entertained or some myths held, such interest may be dampened considerably, resulting to the eventual lack of interest in the activity.

In a learning situation, the teacher can deliberately generate students' interest to learn, and use reinforcement to sustain such interest. It is important that teachers should have a fairly accurate knowledge of students' level of interest.

Obeka (2007) asserted that students' interest in school subjects is an important determinant of academic success. That is, students' interest in school subjects has significant influence on their learning outcomes. This is because interest determines the vigour with which learners tackle their academic tasks. Also, Obeka(2007) pointed out that the level of students' interest is related to their performance in the subject. Stressing further, he maintained that if students lack interest in any subject, they perform poorly in it. Therefore, there is need to adopt strategies that will generate students interest in chemistry

Achievement

According to Magnuson (2007), achievement or performance is the outcome of — the extent to which a student, teacher or institution has achieved

their educational goals. Annie, Howard and Mildred(2007) explained that academic achievement is commonly measured by examination or continuous assessment but there is no general agreement on how it is best tested or which aspects are most important - procedural knowledge such as skills or declarative knowledge such as facts. They said that in California, the achievement of schools is measured by the academic performance index. But in this case chemistry achievement test (CAT) will be used.

On Individual Differences Influencing Academic Performance, Vonstumm, Hell, Chamorro-premuzik(2011) in their study observed that Individual differences in academic performance resulting from differences in academic performances have been linked to differences in intelligence and personality. Students with higher mental ability as demonstrated by IQ test (quick learners) and those who are higher in consciousness (linked to effort and achievement motivation) tend to achieve highly in academic settings. According to them, a recent meta-analysis suggested that mental curiosity (as measured by typical intellectual engagement) has an important influence on academic achievement in addition to intelligence and conscientiousness. Bossaert, Doumen, Buyse and Vaschueren(2011) observed that children's semi-structured home learning environment transitions into a more structured learning environment when children start first grade. Early academic achievement enhances later academic achievement.

Magnum (2007), posits that Parents' academic socialization influence students' academic achievement by shaping students' skills, behaviours and attitudes towards school. Also parents influence students through the environment and discussion parents have with their children. Magnum(2007) concluded that academic achievements can be influenced by parents' socio-economic status. Highly educate parents tend to have more stimulating learning environments.

Lassiter(1995)reported that students' adjustment to academic expectancies has an effect on their academic achievement. She remarked that another very important enhancer of academic achievement is the presence of physical activity. According to him, studies have shown that physical activity can increase neural activity in the brain and exercise specifically increases executive brain functions such as attention span and working memory.

Theoretical Framework

This study derived its basis from the cognitive field or Gestalt psychological theories of learning which are the fundamental theoretical backgrounds for recent innovations in instructional methods and models currently used in the teaching and learning of science. The works of the following Gestalt psychologists will be discussed: Jerome Brunner(1960), David Ausubel(1963), and R. Gagne(1985).

Jerome Brunner's theory of learning

Bruner was one of the founding fathers of constructivist theory. Constructivism is a broad conceptual framework with numerous perspectives, and Brunner's is only one. Brunner's theoretical framework is based on the theme that learners construct new ideas or concepts based upon existing knowledge. Learning is an active process. Facets of the process include selection and transformation of information, decision making, generating hypotheses, and making meaning from information and experiences.

Brunner's theory emphasizes the significance of categorization in learning. To perceive is to categorize, to conceptualize is to categorize, to learn is to form categories, to make decisions is to categorize. Interpreting information and experiences by similarities and differences is a key concept. Brunner was influenced by ideas about cognitive development in children. During the 1940's his early work focused on the impact of needs, motivations, and expectations ("mental sets") and their influence on perception. He also looked at the role of strategies in the process of human categorization, and development of human cognition. He presented the point of view that children are active problem-solvers and capable of exploring "difficult subjects". This was widely divergent from the dominant views in education at the time, but found an audience. Four Key themes emerged from Brunner's early work:

Brunner emphasized the role of structure in learning and how it may be made central in teaching. Structure refers to relationships among factual

elements and techniques. He investigated motivation for learning. He felt that ideally, interest in the subject matter is the best stimulus for learning. Brunner did not like external competitive goals such as grades or class ranking.

Four features of Brunner's theory of instruction:

1. Predisposition to learn. This feature specifically states the experiences which move the learner toward a love of learning in general, or of learning something in particular. Motivational, cultural, and personal factors contribute to this. Bruner emphasized social factors and early teachers and parents' influence on this. He believed learning and problem solving emerged out of exploration. Part of the task of a teacher is to maintain and direct a child's spontaneous explorations.
2. Structure of knowledge. It is possible to structure knowledge in a way that enables the learner to most readily grasp the information. This is a relative feature, as there are many ways to structure a body of knowledge and many preferences among learners. Bruner offered considerable detail about structuring knowledge. Understanding the fundamental structure of a subject makes it more comprehensible. Brunner viewed categorization as a fundamental process in the structuring of knowledge. Details are better retained when placed within the context of an ordered and structured pattern. To generate knowledge which is transferable to other contexts, fundamental principles or patterns are best suited. The discrepancy between beginning and advanced knowledge in a subject area

is diminished when instruction centers on a structure and principles of orientation. This means that a body of knowledge must be in a simple enough form for the learner to understand it and it must be in a form recognizable to the student's experience.

3. Modes of representation: visual, words, symbols.
4. Effective sequencing- no one sequencing will fit every learner, but in general, increasing difficulty. Sequencing, or lack of it, can make learning easier or more difficult. Form and pacing of reinforcement

Application

Brunner emphasized four characteristics of effective instruction which emerged from his theoretical constructs.

1. Personalized: instruction should relate to learners' predisposition, and facilitate interest toward learning,
2. Content Structure: content should be structured so it can be most easily grasped by the learner
3. Sequencing: sequencing is an important aspect for presentation of material
4. Reinforcement: rewards and punishment should be selected and paced appropriately.

Intellectual Development:

Brunner postulated three stages of intellectual development.

The first stage he termed "Enactive", when a person learns about the world through actions on physical objects and the outcomes of these actions. The

second stage was called "Iconic" where learning can be obtained through using models and pictures. The final stage was "Symbolic" in which the learner develops the capacity to think in abstract terms. Based on this three-stage notion, He recommended that using a combination of concrete, pictorial and symbolic activities will lead to more effective learning. Brunner's theoretical framework is based on the theme that learning is an active process and learners construct new ideas or concepts based upon existing knowledge. Facets of the process include selection and transformation of information, decision making, generating hypotheses, and making meaning from information and experiences. Cognitive structure (i.e., schema, mental models) provides meaning and organization to experiences and allows the individual to "go beyond the information given".

Brunner believed that intuitive and analytical thinking should both be encouraged and rewarded. He believed the intuitive skills were under-emphasized and he reflected on the ability of experts in every field to make spontaneous bound. He investigated motivation for learning. He felt that ideally, interest in the subject matter is the best stimulus for learning.

In line with Brunner's theory of constructivism, learners construct new ideas or concepts based upon existing knowledge. Facets of learning as process according to him include selection and transformation of information, decision making, generating hypothesis, making meaning from information and experiences. His enactive, iconic and symbolic stages of intellectual development form strong basis for this study.

David Ausubel’s subsumption theory of meaningful learning

Ausubel's theory is concerned with how individuals learn large amounts of meaningful material from verbal/textual presentations in a school setting (in contrast to theories developed in the context of laboratory experiments). According to Ausubel, learning is based upon the kinds of super ordinate, representational, and combinatorial processes that occur during the reception of information. A primary process in learning is subsumption in which new material is related to relevant ideas in the existing cognitive structure on a substantive, non-verbatim basis. Cognitive structures represent the residue of all learning experiences; forgetting occurs because certain details get integrated and lose their individual identity.

A major instructional mechanism proposed by Ausubel is the use of advance organizers."These organizers are introduced in advance of learning itself, and are also presented at a higher level of abstraction, generality, and inclusiveness; and since the substantive content of a given organizer or series of organizers is selected on the basis of its suitability for explaining, integrating, and interrelating the material they precede, this strategy simultaneously satisfies the substantive as well as the programming criteria for enhancing the organization strength of cognitive structure." .

Ausubel emphasizes that advance organizers are different from overviews and summaries which simply emphasize key ideas and are presented at the same

level of abstraction and generality as the rest of the material. Organizers act as a subsuming bridge between new learning material and existing related ideas.

Ausubel's theory has commonalities with gestalt theories and those that involve schema (e.g., Bartlett) as a central principle. There are also similarities with Bruner's "spiral learning" model, although Ausubel emphasizes that subsumption involves reorganization of existing cognitive structures not the development of new structures as constructivist theories suggest. Ausubel was apparently influenced by the work of Piaget on cognitive development,

Application

Ausubel clearly indicates that his theory applies only to reception (expository) learning in school settings. He distinguishes reception learning from rote and discovery learning; the former because it doesn't involve subsumption (i.e., meaningful materials) and the latter because the learner must discover information through problem solving.

Example

Ausubel (1963) cites Boyd's textbook of pathology as an example of progressive differentiation because the book presents information according to general processes (e.g., inflammation, degeneration) rather than by describing organ systems in isolation. He also cites the Physical Science Study Committee curriculum which organizes materials according to the major ideas of physics instead of piece-meal discussion of principle or phenomenon.

Principles

1. The most general ideas of a subject should be presented first and then progressively differentiated in terms of detail and specificity.
2. Instructional materials should attempt to integrate new material with previously presented information through comparisons and cross-referencing of new and old ideas.

Ausubel's theory is in line with this study as according to him, Advanced Organizers act as a subsuming bridge between new learning materials and existing related ideas or cognitive structure. These new ideas should be related to the existing cognitive structure on a substantive non-verbal basis. This arrangement controls the rate of forgetting as it occurs because certain details get integrated and lose their individual identity. In a nutshell, Ausubel emphasizes that meaningful learning occurs when new concepts are linked to familiar ones existing in the learners' cognitive structure (Novak and Gowin, 1984). Ausubel's theory has provided the theoretical basis for developing concept maps and organizing the simulation play environment which can be utilized as practical teaching and learning techniques.

Gagne's Conditions of Learning Theory

Gagné (1985) developed his five categories of learning outcomes based on the characteristics of the content that a learner must learn. His outcomes do not consist of any particular order or complexity of levels, other than the sub-categories within the Intellectual Skills category. Gagné separated Bloom's

knowledge class into a category he named verbal information, and he added another category of learning outcomes he named cognitive strategies. He believed cognitive strategies were learning strategies that learners adopted and applied in the process of learning, and that they are not subject specific.

Gagné's conditions of learning theory draws upon general concepts from various learning theories in order to define what learning is. The theory looks at the observable changes in human behaviour that confirm that learning has occurred. Gagné's theory provides an answer to the question, "what is learning?" In answering that question, Gagné provides a description of the conditions under which learning takes place by referring to situations in ordinary life and in school where learning occurs, and by referring to experimental studies in learning.

Gagné (1985) postulates that proof of learning shows by a difference in a learner's performance before and after participating in a learning situation. He claims that the presence of the performance does not make it possible to conclude that learning has occurred; but instead, it is necessary to show that there has been a change in performance. In other words, the capability for exhibiting the performance before learning requires consideration as well as the capability that exists after learning.

This work is in line with Gagne's postulate that proof of learning shows by a difference in a learner's performance (achievement) before and after participating in a learning situation, thus, the need for pretest and posttest. In

order words, the capability for exhibiting the performance before learning requires consideration as well as the capability that exists after learning.

Theoretical Studies

Role of chemistry, and its importance in teaching and learning.

Chemistry is one of the science subjects that deals with the study of matter, its changes, composition properties and uses (Ababio,2004). Chemistry education exposed learners to the environment, processes and attitudes as well as equipped them with the professional skills needed for their self empowerment. A chemistry teacher has both knowledge as well as skills in chemistry for the impartation of knowledge to the students. Chemistry teaching should involve creative ways of integrating the acquisition of self-reliant skills and the learning activities of the learner in the classroom (Igboegwu & Ikokwu, 2012). Thus the teacher is the implementer of the curriculum and the designer of the learning activities. The chemistry curriculum as a teaching syllabus has among others the following general objectives derived from the National Policy on Education (FRN, 2013). These include.

- to provide the students with basic knowledge in chemistry content and, sequencing.
- show chemistry in its inter-relationship with other subjects
- show chemistry and its link with industry, everyday life benefits and hazards.

In accordance with the above stated objectives, the content and context of the syllabus place emphasis on field studies, guided discovery and conceptual thinking. The syllabus intended to provide courses in chemistry as well as meet the needs of the society through relevant and functional content delivery, method process and application (FRN, 2004). This focal point resulted in the adoption of a spiral approach in the sequencing of science. The teaching syllabus was organized in five sections, namely: topics performance-objectives, content, activities and notes. This syllabus will provide maximum guidance to the classroom teacher with relevant diversified strategies towards arousing and sustaining the interest of the learner for meaningful and deliberate human development.

Ikwuanusi (2011), observes that integrating self-reliance skills in chemistry curriculum and delivering them using appropriate strategies expose the students to resources and opportunities available in their immediate environment and at the same time bring the students to real world activities. Udofia (2009) concludes that meticulous application of proper strategies on the inculcation of these skills proposed in the chemistry curriculum will result in a self-reliant person interchangeably called the manager, innovator, decision-maker, organizer or co-ordinator.

Instructional Strategies for Teaching Chemistry.

The primary concern of education is the propagation of all that is good and worthwhile in any culture from one generation to another. These include

knowledge, skills, attitudes, and awareness, values and evaluation ability needed by the individual to survive in his environment (Imoko 2004). In order to achieve these objectives teachers need to adopt the right teaching and learning strategies which can lead students to analyse, think and reflect rather than memorizing facts. Whatever strategies selected can fall under three basic types which Ahove (2001) named as:

- Affective-based strategies
- Psychomotor-based strategies
- Cognitive based strategies

He explained that the affective based strategy facilitates interest and desirable positive behaviours, the psychomotor based strategies help learners to actively acquire the basic skills needed while the cognitive based strategies enable the learner to acquire knowledge and awareness and all of these result in greater achievement.

. Imoko (2004) further explained that it is an overall plan or a large-scale pattern of activities, geared towards achieving a goal. In this study, the terms method, approach, technique and strategy are used interchangeably to mean the same thing. Ahove (2001) identified some strategies for teaching science education concepts in various disciplines. Some of these strategies that will be discussed are Lecture/Discussion, Problem Solving, Use of Analogies Project Method, Dramatization, Concept Mapping, Simulation-Game.

Lecture/Discussion

This strategy lays more emphasis on teacher's knowledge of the topic than that of the students. In the pure lecture mode, the teacher dominates the class teaching. The teacher tells the students what he wants them to know and the students listen, copy notes and memorize. Students are rarely involved. The lecture method assumes the teacher to be an embodiment of knowledge while the learner is ignorant (Imoko, 2004). After presenting the lesson, the teacher repeats or emphasizes the important points in the lesson, asks and invites questions from the students.

The advantages of this method include:

- It allows for adequate coverage of the course content in a short time
- Economy of time and materials;
- It fosters good teacher-student relationship.
- Easy to prepare;
- Students can collect valid notes from the teacher. Ahove,(2001) pointed out the disadvantages of this method as:
- It is teacher-centered. The teacher monopolizes the lesson.
- It encourages rote learning or memorization.
- It favours high achievers and gifted children.
- Lacks active participation of students.
- Does not cater for individual differences.
- Does not take into consideration students initiatives

- Abstract presentation of ideas.

Problem Solving

Problem solving as an instructional strategy is an investigation approach to learning in which learners are given a task or problem to tackle (Oduwaiye 1998). It requires students to use a variety of skills to obtain results and these activities are carried out systematically in stages as shown below.

- Describing and Clarifying problem
- Development of hypotheses, assumptions, ideas, courses of action and making decision
- Action plan and implementation-testing the hypotheses.
- Evaluation of the action, drawing conclusions and applications

  Students who engage in problem-solving generally learn to become responsible, capable and creative individuals (Ahove 2001). It enhances learners' ability in adopting information and reasoning to overcome obstacles and barriers. Problem solving is a general approach involving other methods such as inquiry, case study, simulation-games/role play, research, discussion and several others in the acquisition of knowledge, skill, attitude or attitude change (UNESCO-UNEP 1986 in Oduwaiye 1998). The report explained that in all these methods, there will be a problem or task to be tackled but the steps taken in finding a solution to the problem may differ in

details. The advantages of problem solving methods according to Ahove (2001) are:

- It motivates students to learn.
- It makes students active-learner by doing things.
- It develops sensitivity, curiosity, enthusiasm and perseverance in learners.
- It builds confidence in learners.
- As a demerit, lack of materials, guidance, and time can hinder learning via the problem solving strategy.

Use of Analogy

Analogy is an exposition technique, sets of information which are adequately similar in important aspects to permit transportation of attributes across sets usually from the familiar to unfamiliar (Ahove, 2001). Analogy is not illustration or examples: rather it is a linkage between similar features of concepts, principles and formula (Ahove 2001), thus, making for vividness and easy understanding of abstract concepts. (Amaechi, 1995). This linkage between analogues and the target may be either structural; or functional. Structural analogue involves physical attributes of the target e.g, a bucket of sand with flat surface to show an exposed area of land. Functional analogue is used to illustrate the behaviour of the target, for instance the use of fan to illustrate wind affecting bare land causing erosion (Ahove, 2001).

Advantages

- It facilitates comprehension as it links the known (analogue) to the unknown target).
- It is student centered.
- It motivates students to learn.
- It encourages students to be familiar with their environment.
- It provides visualization of abstract concepts.

Disadvantages;

- Some topics may lack analogy.
- Misconception of ideas may result if not well handled.
- It hinders learning if an inappropriate analogue is selected.
- Unfamiliar analogies to the learners can hinder learning because it is strange to them.
- Learners may focus on analogue rather than the target which is the subject matter.
- Incomplete transfer of attributes by the teacher from analogue to target can cause misunderstanding for the learners. (Ahove,2001;Okebukola et al. 1997,)

Project Method

This strategy classically involves breaking down a topic into integral components or sub-topics. The students are equally divided into groups and

then assigned the sub-topics to carry out investigations and produce reports. The role of the teacher is to provide guidance where and when necessary and to monitor the progress made by each group. The groups are free to adopt whatever methodologies they deem appropriate for tacking the task.

The merits of the methods are

- It keeps students busy.
- Students acquire skills for investigation.
- It encourages independent study with new discoveries.
- The teacher has more time for other class routines.
- It encourages meaningful learning by encouraging better understanding,

Demerits:

- It is time consuming and only a small aspect is covered.
- It may be difficult in the absence of research materials, eg, books etc.
- Individual differences are not considered.
- Students can hire someone else to do it for them.

Dramatization

Dramatization is an act or practice of using actions with or without words to show meaning, or actions meant to entertain, educate and inform. It can be used by the teacher to inspire such activities as memorization, development of imagines and drama in the students (Ajewole, 1991). It allows for students

participation and in the process develop desirable social skills. Furthermore, it provides the pupils with opportunities for independent activities, work, action analysis, interpretation of facts and logical argument. Ajewole(1991) identified the following steps in dramatization.

Identify the problem to the dramatized

- Prepare the script and identify the inherent values portrayed;
- Allow students to select their role/character;
- Discuss with each actor/actress his/her role;
- Set the stage for the drama and give students enough time;
- Use guided question for follow-up discussions; and
- Evaluate the actors performance and the general proceedings for future improvement

Merits

- It encourage students' participation
- It is student-centered
- It stimulates interest and is fun for all.
- The memory remains with the students.
- Participants are carried along from start to finish.
- It is raises the interest of the students towards what is being taught and the ideas are retained for long.

Demerits

- Some students may be carried away by the fun of what is being dramatised.
- It is time consuming (preparation & rehearsal)
- It can mislead if not well directed.

For effective teaching and learning of chemistry, especially the environmental science concept aspects of it, a skillful combination of strategies can go a long way towards achieving the objectives. Ahove (2001) advised that such choices of strategies should be guided by the following considerations.

- the objectives of teaching the particular topic;
- the content of the lesson;
- learners' readiness and preparedness; and
- modes of evaluation to attain the set objectives.

Learning, Concept Mapping and Simulation-Game Approach

Learning:

The definition of learning varies among the various and different learning theories. For instance, learning means to bring changes in the behaviour of the organism (Chauhanm, 1985). Gagne (1992) defined learning as change in human disposition or capacity which persists over a period of time and which is not simply ascribable to the process of growth.

Melvin (1970) as in Chauham (1985) defined learning as a relatively enduring change in behaviour which is a function of prior behaviour (usually

called practice). To Coffey(2000), learning is a relatively permanent change in behvaiour. Further, the cognitive or information processing approach describes learning in terms of the thought processes that occur within the brain.

Despite the seeming varied definitions of learning as a process, there are some attributes that are firstly, the issue of change in behaviour or capability that are central to all the definitions. It does not include changes due to growth (maturation), illness, fatigue, or use of intoxicants. Secondly, the change must be due to experience, study, training or practice. Another common and uniting characteristic in these definitions is that learning is not directly observable but manifests in the activity of the individual. Lastly, learning results in some change of an enduring nature. The major point of difference according to Ezeudu (1995) is how the change takes place. In the pursuit of the best understanding of how learning takes place, two groups of theorists have dominated the science. These are: the stimulus-response associations theories and the cognitive field theories.-

The stimulus-Response associations are concerned with observable overt behavioural changes of an organism and how these behavioural changes could be controlled and so their approach to learning is also referred to as behaviourism. They posit that learning is caused due to the formation of associations between stimulus and response. In addition, they maintain that the quality of learning and retention depends on the strength and the nature of the bonds or links or associations between the stimuli and the responses.

The behaviourists are also of the view that the environment shapes behaviour. According to Imoko (2004) the theory emerged from operant conditioning using reinforcement. These theorists include 1.P. Pavlov, E.I. Thorndike, B.F. Skinner, etc. The stimulus-Response association theory has found various applications in learning such as in teaching, programmed learning, computerized systems and instruction such as well as in behaviour modification.

On the other hand, the cognitive field theorists or Gestalt psychologists maintain that the human mind is actually involved in learning. Otherwise, the learning will not be meaningful. They are of the view that learning is a rearrangement of the thought pattern and hence stresses the importance of structure and provision of opportunities for initiative thinking in the class room. They also emphasized issues like insight, perception, discovery and understanding in any learning situation. The proponents of this theory include: J.Brunner,J. Piaget, R. Gagne,D. Ausubel ,J. W. Lewin and M.Koffka. They see the stimulus-response association (S.R) as too trivial and mechanical to explain and understand learning, instead they view learning as an interaction between information and this interaction results in meaningful lZearning.

The specific emphases of four cognitive field theories are stated below: piaget's developmental psychology is based on a psychological performationist philosophy (Akpan,2000) which assumes that the cognitive development unfolds in fixed sequences up to maturity. In other words, the child's mental activity is organized into structures called schemata or patterns of behaviour (Imoko,

2004). Piaget emphasizes that children do not move abruptly from one period to another, and that the child's capacity to learn depends on the stage of his development in age. He proposed four of such developmental stages, as the child progresses from infancy to maturity, namely sensory motor, the pre-operation, the concrete operations and the formal operation stages. Piaget also gave a profile of the thought processes of each of the stages.

The implication of Piaget's theory is that certain periods in the child's mental development are critical and therefore should be taken into consideration when planning the curriculum or even instruction. Therefore, before a new concept is introduced to the child, there is the need to ascertain and ensure that he has mastered the pre-requisites for learning the concept. The simulation-game and concept mapping by their nature will require the teacher and students to break up the main concepts into the sub-ordinate concepts and arrange them in a hierarchical order. The choice of esterification and saponification in SS3 suits the child's ability and maturational level.

Gagne's theory of learning hierarchy postulates that learning is best when one moves from mastery of the smallest conceptual units to the more general and more inclusive. This is organizing learning tasks for intellectual skill in a hierarchical order according to complexity. The theory holds that instruction can bring about the learning of an intellectual skill only if certain identifiable subordinate skills are present in memory, since this will also provide the basis for the sequencing of instruction. The implication of his theory is that for an

individual to learn a concept, he should first learn the subordinate concepts (Gagne, Brigand, Wager, 1992). The simulation-game and concept mapping strategies utilize the Gagne's hierarchical order.

Brunner, on the process of learning, said "we begin with the hypothesis that any subject can be taught effectively in some intellectually honest form to any child at any stage of development" Brunner, 1960:33). This statement by Brunner himself implies that the child is ready to learn when the teacher is ready to teach. It, therefore, follows that teacher effectiveness in the class is very crucial in the formation of new concepts. Brunner's theory stressed the cognitive effectiveness of learning by discovery. He is of the view that individuals are more likely to remember concepts if they contribute to the discovery (Anyigbo, 2005). Brunner recommended learning by doing or by behaving i.e. doing something active that one can control. He also stated that learning relies upon images and pictures to represent information that can be interpreted and used as a basis for action. Learning is sensitive to specific training and teaching and so he believes that for any knowledge in the culture, there is a corresponding form that is within the group of a young learner at the stage of development where one finds him. The cognitive growth of a child takes place in stages. The child should be helped to pass progressively from concrete thinking to the utilization of more conceptually adequate modes of thoughts. As a matter of fact, Brunner emphasized that the learner should be inquisitive, explorative and initiative in the process of learning. He therefore identified four processes that can facilitate

teaching and learning and according to Imoko (2004) they include discovery, ignition, analytic language and readiness. Concept mapping and simulation-game strategies help the learner to discover the key concepts and concept relationships embedded in each topic.

Kola-Olunsanya (1998:37) states “the most important single factor influencing learning is what the learner already knows. Ascertain this, and according to Ausbel, an individual’s capacity for new learning or problem solving is a function of the adequacy of relevant concepts which tend to develop with age but at the same time cognitive differentiation is experience inclined (and hence culture dependent). To ascertain what the learner already knows, to identify elements in the learners’ existing knowledge store that are relevant, and concepts available in the learners’ cognitive structure, young children require concepts through concept formation. After that, most new concepts are required through concept assimilation, progressive differentiation and integrative reconciliation (Ahove, 2001). A child’s cognitive development, according to Ausubel, is directly a function of his language development and his experience with concrete objects. He has also been famous for advanced organizers which could be likened to previous knowledge.

Interest as a Factor in Learning

Educationists have often laid serious emphasis on the need to equally develop the affective domains of learners’ behaviour (Akinsola, 2002). Unfortunately, experience has shown that in practice, education has been

concerned with cognitive learning mainly, at the expense of the affective and psychomotor aspects. The unfortunate situation is to the extent that the degree of success shown by students is used for evaluating schools and educational products (Osuafor, 2001). According to Meharene and Lehaman(1978) as cited in Osuafor, (2001). The affective domain deals with beliefs, attitude, interest, motives needs and satisfaction, feelings and emotion (Chauhan 1978) Generally, it is believed that the affective disposition of the students has a direct relevance to his ability to learn, his interest in learning and his attitude towards the value of education (Alio,1997). It then follows that information/knowledge about the learner's interests, personalities and students is of paramount importance to educators to help them understand the learner, guide his future activities, and also make more valid decisions on matters concerning their schools and educational products

For the development of positive scientific attitudes (in the students with a view to solving scientific problems), there is the need to get their interest in such scientific and educational issues. Therefore, part of the problems of this study was to determine the effects of concept mapping and simulation game strategies on the interest of students in the selected organic chemistry concepts.

Laycook and Munro (1966) in Imoko (2004) described interest as one practical class of attitude which are always positive and are associated with objectives or activities that are need-satisfying and pleasure giving. Interest has

also been seen as the tendency to seek out and participate in certain kinds of activities in preference to others (Njoku,1997). He went further to explain that:

> *Since preference is involved in interest, it can be deduced that the individual's interest in various activities involve some kind of scaling. Activities that score high in the individual's scale of preference will tend to be of interest to that individual and they are preferred in matters of choice of activities. (Njoku 1997:5)*

Okwor (1981) in Alio (1997) said that interest is the interaction which forces or compels a child to respond to a particular stimulus. In other words, a child develops interest for a particular stimulus that arouses and attracts him/her. Put in a classroom situation, if a child finds a lesson and or the teacher's method interesting, the child will definitely pay attention to the lesson. Osuafor (2001)also stated that in interest, the thing perceived has a special attraction for the mind and stands out among the other presentations and by implication interest is able to compel attention. It then follows that interest cannot be forced, but must always come as a result of the students' curiosity to learn. Igboegwu (2005) also viewed interest as an emotionally oriented vocational trait, which determines students' vim and vigor in tackling educational programmes or other activities. The interest in a particular thing is a feeling of pleasure in an activity, to become highly experienced and to continue to participate in that activity (from which some form of pleasure is derived) with zeal or vision.

Furthermore Nworgu (1992) saw interest from two perspectives namely:(1) Interest as the cause of actions and (2) Interest as the effect of an

activity. He went further to explain that interest becomes the cause of certain actions when for instance people do certain things they do because they are interested in them. In this kind of activity interest acts a drive or motivation that propels individuals to act in such ways. On the other hand, he continued interest becomes the effect of an activity when for instance; students develop interest in a particular subject because of the teacher's period of presenting the learning materials in the subject. This further emphasizes that students are bound to pay attention as the lesson progresses if that particular lesson and the teacher's method of teaching is interesting to them, and this emphasizes the importance of teaching method in motivating, arousing and sustaining the interest of students in a particular subject. Therefore, interest as the effect of an activity was applied in this study.

Generally speaking interest and attitudes largely influence people's actions and these interests are shown in our choice or preference for an activity, event, issue, occupation or person. According to Osuafor (2001) people have a tendency to devote more effort and energy to the activities they like and to this effect, when children are interested in an activity, they tend to persevere, spend time and even undertake extra work to do it well. Simply put, interest can influence how well students learn. Osuafor (2001) advised that it is important to discover what children are interested in or get them interested in what we want them to learn. Interest is indispensable for learning and without interest; real

education may not be achieved. Shorter and Stone (1976) in Imoko (2004) gave three types of interests to include:

- expressed interest
- manifested interest
- inventoried interest

They explained that while expressed interest is the verbal declaration of interest in an activity, manifested interest has to do with participation in the activity and is actually shown by the extent of participation or degree of involvement in the activity. Inventoried interest on the other hand gives the subjective estimates of a person's likes and dislikes on a large number of items surrounding the activities or objects of concern usually listed in an interest inventory. Inventorial interest was applied in this study.

Loveday (1967) in Alio (1997) informed that tests of interest can not be used with young children but from mine years of age, useful results can be obtained. In line with this, is the view of Nworgu (2004) who stated that interest tends to be unstable for young children, but becomes progressively more stable with age particularly after adolescence but they are never permanently fixed.

Literature revealed that the teaching method or strategy employed by the teacher is one of the major factors that influence students' interest and achievements in science. The way students interact with their teachers during instruction may influence their interest towards the subject being taught (Osuafor 2001).

Since an individual is naturally actively involved in activities of interest, it then becomes worthy of note that any attempt to tackle the problem of poor achievement in chemistry will be a failure if the students' interest is not taken into consideration. Therefore, teachers need to adopt teaching strategies that arouse, motivate and sustain the interest of the students in order to enhance better achievement (Osuafor, 2001 & Imoko, 2004). This study therefore investigated the extent to which concept mapping and simulation-game strategies will respectively enhance the interest and achievement of students in organic concepts in chemistry.

Gender as a Factor on interest and achievement of students

Gender is a socially ascribed differentiation of feminine from masculine (Imoko, 2004). Quakley (1970) as in Nworgu (2005) used the word gender to described certain characteristics of men and women which are cultural and socially determined while those that are biologically determined are regarded as sex.

Some researchers have reported the prevalent significance of gender on the interest and achievement of students in the sciences, with particular reference to chemistry in favour of males (Ezeugo and Agagwah, 2000; Mari, 2002 ; Ifeakor, 2005; Isah, 2005; & Okwo and Otubah, 2007). This has been attributed to factors which include the teaching strategies adopted (Nworgu, 2005), economic, cultural, social, political and religious beliefs (Isah, 2005). Others include preference of boys' education, lack of sustained government policies,

early marriage etc. According to Akanbi (1999), women education was not conceived as a process aimed at producing accountants, engineers, doctors, administrators or any of these prestigious professions necessary for nation building, but cooks, housewives and mothers. In confirmation of this view, Perry and Down, (1992) cited in Isa, (2005) had this to say;

> *Thus women were educated to accept their roles as mothers and wives. To this end, they were taught how to perform the traditional roles of house wives and mothers. The emphasis of women education was on domestic science involving the preparation of meals, provision of care for the husband and preparation towards motherhood (Isa 2005,48).*

Furthermore, Oganwu (1996) stated that in Nigeria, women are expected to play the second fiddle and to take low status jobs. They traditionally have been debased and dishonoured by the fact that they are supposed to consider motherhood as the principal purpose of their existence:

> She is brainwashed by a culture of superior male dominance and is left to do with a life career in peasant farming or petty trading. Her picture elicits some empathy, haggard-looking. Old and almost balding hair that has dutifully responded to pressures from heavily laden baskets of farm products (Oganwu, 1996:69).

Surprisingly, Njoku (1997) reported that the relative superiority of males to females in scientific attitudes, interest, participation and overall achievement is a world wide phenomenon. The low participation of females actively in science (chemistry), predicts a serious draw back in the development process. This is based on Isa's assertion that countries with higher female enrolment rates in

science have shown higher levels of economic productivity, lower fertility, material morality and longer life expectancy than countries with lower female enrolments (Isa, 2005).

Females are among the initiators of events that result into environmental problems which are mostly due to the ignorance of the functions and structure of the ecosystem. They are often involved in activities dictated by culture such as fetching water and firewood, farming, etc and all these impinge on the environments in one way or the other. When we consider the all-important roles of women (females) as the first teachers of our children and closeness to the environment, capacity of influencing others (husband, children, house helps etc.) who in turn influence the environment, the need for their active participation and demonstration of interest in scientific issues can not be overemphasized. Yet women (females) according to Orukotan and Balogun (2001) are systematically discouraged from undertaking training in science education as a result of bias which perceives these spheres as masculine disciplines. Continuing, they further reported that females constitute about 50% of Nigeria's 120 Million people and this proportion is an important factor to reckon with in socio-economic terms.

The United Nations Population Fund (UNPFE) (1991) and Warren (1991) all in Nzewi (2001) referred to women as managers and the custodians of the managers' respectively. According to Nworgu (2005) science is everywhere and everyone can do science. He, therefore, advocated the need for science teachers to understand the importance of using gender equitable instructional strategies in

the science classroom environment. In view of this assiduous relationship between women and science, this study determined the influence of gender on the achievement and interest of students in some organic chemistry concepts.

Empirical Studies

This section of the literature review will look at some studies that have been carried out in the area of methodology in chemistry.

Studies on instructional strategy on chemistry

Akinsola and Igwe (2002) investigated the relative effects of Meta cognitive strategy framing on students' achievement in selected difficult chemistry concepts. The study used a total of 187 students from two co-educational colleges in Ibadan. The design of the study was quasi-experimental pre-test, post test, non-randomized control groups. Three hypotheses guided the study. Data collected were analyzed using mean, standard deviation t-test comparisons and one-way ANOVA. It was found, among other things, that students exposed to the framing strategy performed significantly better than those exposed to the conventional lecture method. Another finding was that gender was not significant though gain differences were recorded in the mean achievement scores. This study is relevant to the present study because both focused on influence of teaching strategies on students' achievement. Influence of gender was determined in both cases. The present study also utilized some of the statistical tools used in the reviewed work.

Agbai (2006) investigated the Effects of interaction of Teaching Methods and study Habits on Senior Secondary Students Achievement and Interest in Chemistry. A total of 240 SS 2 chemistry students randomly selected from the Ogoja Education Zone of Cross-Rivers State participated in the study. The design of the study was quasi-experimental and 3 intact classes were used; 2 treatment, 1 control. Three instruments were used to obtain data and they are: Chemistry Interest Inventory, Study Habit Inventory for Chemistry Students (SHICS) and Chemistry Achievement Test (CAT)

Results of the analysis revealed that teaching methods have statistically significant effects on the achievement and interest of students in chemistry. Study habit has significant effect on achievement but not on interest in the subject. This present work investigated the effect of two teaching methods on achievement and interest of students just like the above reviewed study. Secondly, both utilized achievement test and interest inventory as modes of data collection.

Udobia (2002) assessed the Effect of pedagogy on the Output of Instructional Programmes in Science, Technology and Mathematics (STM) the purpose of the study was to find out the effect of teaching method, classroom management and education on the quality of the output of instruction STM. The research design was a survey and structured questionnaires were used to extract information from the respondents. The sample comprised 200 STM teachers in Rivers State randomly selected. The z-test statistics was used for data analysis.

Results of the study showed that pedagogy has a significant influence on the output of educational programmes in STM. Another report from the study was that good pedagogical approach has a very positive and fruitful effect on the products as it assists the learner to learn well. Literature reviewed pointed concept-mapping and simulation-game as good, problem-based and activity oriented instructional strategies. Can they enhance the achievement and interest of students in the selected environmental concepts in chemistry? This is what the present study investigated.

Opera (2002) investigated the Effects of Self-regulation Process chemistry Analysis. A total of 284 SS 2 chemistry students randomly selected from 4 secondary schools in the Orlu Education Zone of Imo State were involved in the study. The design of the study was quasi-experimental, pretest-post test, non-randomized. Six null hypotheses guided the study. Interaction effects between gender and teaching methods on achievement and interest were also determined. Results showed that self-regulation process significantly enhanced students' achievement and interest in quantitative chemical analysis. Gender did not affect achievement but had a significant effect on students interest. There was no interaction effect between gender and teaching method on students' achievement. However, interaction effect was reported between gender and teaching method on students' interest in the study under review. The above study is related to the present study in the following ways:

1. Both studies investigated the effects of teaching methods on students' achievements and interest.
2. Both investigated interaction effects of gender and teaching methods on students' achievements and interest.
3. The design of the reviewed study was also adopted in the present study.

In yet another study designed to further clarify the claim by several authors that methods of instruction could change students' attitude positively towards science (chemistry). It was the belief of the author that if students were allowed to develop higher cognitive processes, through problem-solving strategies, that students' attitudes towards chemistry would be enhanced. Students' attitudes towards chemistry was investigated by Adesoji (2008). The study involved 360 SS 2 chemistry students randomly selected from 12 schools in Osun state, Nigeria. The unit in chemistry was Electrolysis. The design of the study was experimental involving pre-test and post-test. The methods of data analysis were means, ANOVA. The findings of the study showed that students in the experimental group developed more positive attitudes towards chemistry after treatment. The researcher further recommended that teachers should use problem-solving strategies in their teaching in order to win many more students to chemistry. Adesoji (2008) reported on the effect of teaching method on the attitude of students towards chemistry. The present study focused on the effect of teaching methods on

achievement and interest in chemistry. The design of the reviewed study was used in the present work.

The study aimed at determining the gender related differences in the acquisition of formal reasoning ability; the pedagogic implications of teaching chemistry using process-based approach was carried out by Mari (2002). The study involved 38 secondary school students randomly selected from secondary schools in Kaduna state. The design of the study was pre-test, post-test and t-statistics was used for data analysis. Results form the study showed that the initial gap between the male and female subjects in formal reasoning ability, in the pre-test was bridged in all the Chemata (conservation control of variables, proportional reasoning, probability reasoning and combinational reasoning). Based on this finding, one of the major recommendations made was that process-based instructional strategies should be introduced in the early years in secondary school as a means to reduce, if not totally eliminate gender-related differences in students abilities. The above reviewed study is relevant to the present study. Firstly, the interaction of teaching methods and gender on achievement and interest of the students in the organic concepts was also determined in the present study. In addition, the teaching methods-concept mapping and simulation-game are process-based strategies as advocated in the study reviewed.

Ekewere (1997) investigated the effects of meta-cognitive strategies of concept mapping and framing singly and in combination on students' attainment

of some chemical concepts perceived as being difficult to learn. The influence of gender on achievement was also examined. The researcher adopted a quasi experimental pre-test, post-test control group. The study involved 200 SS II chemistry students selected from 4 schools in Ibadan. Results showed that there were significant effects of treatment on students' concept attainment at the classificatory, formal and use of concept levels of attainment. No significant mean and interaction effects of gender were recorded. Ekewere (1997) attributed the poor achievement of students in chemistry to factors which include the implementation of the chemistry curriculum in a teacher-centered way, with text books as the only source of knowledge, and students not being exposed to using their initiatives in the learning access. The researcher, therefore, advised chemistry teachers to employ innovative instructional strategies that empower students to take charge of their learning while teaching particularly concepts generally perceived as difficult. By so doing, emphasis will be shifted from the teacher-centred mode of instruction. The present study employed the design and one of the teaching strategies in the above reviewed work. In this research, the concept mapping strategy is compared with simulation-game in terms of their efficacy in enhancing achievement and interest in another unit in chemistry.

Ifeakor (2005) evaluated the effect of commercially produced the computer-assisted instructional package (CPCAIP) and gender on students' academic achievement in chemistry. The CPCAIP was compared with the conventional teaching method, (CTM). The design of the study was the

equivalent control group quasi experimental involving four intact classes. The sample for the study comprised 140 Chemistry students from two private schools in the Onitsha North Local Government Area of Anambra State, Six research questions and six null hypotheses guided the study. Data analysis was done using mean, standard deviation and ANCOVA. Results of the analysis revealed that CPCAIP had a significant effect on students' cognitive achievement and interest in chemistry. Gender was also reported as a significant factor in achievement. The researcher therefore advised government to make necessary previsions for the use of the CACAIP technique in the classroom by teachers.

Concerned by the poor achievement of students who offer chemistry at the West African Examination council, (WAEC), Ayodele (2002) investigated the obstacles to the Effective Teaching and Learning of Chemistry at the Secondary School level using the Federal Capital Territory (F.C.T.) schools. A total of 200 SS 3 students and teachers randomly selected from 20 secondary schools in FCT took part in the study. The design of the study was a survey and data were collected using questionnaire. Obstacles identified include; family and poor teaching methods, lack of qualified teachers, non-availability of instructional materials among many others. The researcher made a lot of recommendations one of which is that chemistry teachers should employ meta-cognitive, activity-based strategies during instruction. This study therefore investigated the

effectiveness of two activity based strategies-concept mapping and simulation-game in enhancing achievement and interest in organic concepts in chemistry.

Asiyai (2005) declared that a number of teaching methods (like discussion, lecture, questioning, discovery etc.) which have been used in the past have not yielded expected results. Other studies that reported same include Innomesia and Unuero (2003), Kola-Olusanya (1998). Asiyai (2005) therefore advised that when chemistry is taught using the activity and problem-based method, the student, can easily view at a glance all the concepts in the topic taught, and also acquire meaningful learning. This study therefore sought to determine the comparative effectiveness of concept mapping and simulation game which are activity and problem based teaching strategies in teaching some organic concepts in chemistry. This is with a view to infusing the right scientific knowledge, awareness, interest, attitude and skills in the learners as will be measured by OCSAT and OCSII

Studies on Concept Mapping

Concept map has its roots in education, and education and learning still constitute the bulk of its use. Since the development of concept mapping by Joseph D. Novak and his associates at Cornell University in the 1970's, a lot of studies has been carried out on this teaching strategy in different areas like biology, chemistry, physics, integrated science, mathematics, etc.

The goal of Jegede, Alaiyemola and Okebukola (1990) was to test whether the addition of concept mapping to instruction would aid achievement

and reduce anxiety. The study involved a total of 51 SS students. The design of the study was quasi-experimental. There was random assignment of classes to condition. The subject matter in Biology was nutrition in green plants and respiration cells. The results of the study were in favour of concept mapping. There were positive effects in favour of concept mapping in both achievement and for anxiety reduction.

In a related study, Schmid and Telaro (1990) sought to test the effectiveness of concept mapping on high school Biology and to assess this by students' ability levels. The study was conducted in Montreal, Canada and involved 116 students at levels "4 and 5" of the Canadian system. The subject matter was a unit of a biology course on the nervous system. The experimental design combined treatment and control crossed with three levels of academic ability (high, medium and low). The results indicated that the use of concept mapping was intensified as groups went from high to medium and to low ability levels. The researchers observed that concept mapping took the learners to greater levels because it required them to take a deliberate approach to learning.

Okebukola (1992) investigated the attitude of science and mathematics teachers of SS 1, SS 2 and SS 3 towards concept mapping and vee-mapping inventory diagnosing as meta-learning tools in science and mathematics. Data were collected using Attitudes towards Concept and Vee-Mapping inventory (ATCVMI). A sample comprising 48 Biology, 36 chemistry, 24 physics and 33 mathematics teachers in Nigeria were used for the study. The result of the study

revealed favourable attitudes of the teachers towards concept and Vee-mapping. The teachers found the teaching strategies to be highly usable by their students', and beneficial to learning.

Furthermore, Okebukola (1992b) attempted to answer the question 'can good concept mappers be good problem solvers in science? The investigation involved 40 students drawn from a pool of students who experienced co-operative and individualistic concept mapping experiences for six months and were adjudged to be good concept mappers. The study found the concept mapping group to be significantly more successful in solving biological problems than the students in the control group.

Ezeudu (1995) carried out a study to ascertain if the use of concept mapping could be found significantly effective in accelerating students' achievement in organic chemistry in Nigeria. The study involved SS II chemistry students in Nsukka, Enugu state. The subject matter were alkanes, alkenes and alkynes. She found out that there was a significant difference between the achievements and interest of students taught with the concept mapping strategy and those who were taught using the conventional approach-lecture method. The difference was in favour of those taught with concept mapping. The study also reported the existence of a significant interaction effect between gender and concept mapping on students' interest in organic chemistry. The design, and method of data analysis in the above study would be employed

in this study. Though the two studies are in the same subject area, the units or subject matter considered are different.

In a similar study, Jegede et al (1990) went on to test if the addition of concept mapping to instruction in a physical science course would improve or enhance achievement, reduce anxiety towards physical science on the part of students and also reduce anxiety about teaching physical science on the part of the teachers. The study was conducted in the U.S using a total of 104 pre-service undergraduate science education students. The subject matter in physical science included electricity, heat, light, sand, matter, energy and basic mechanics. The pre-test-post test mode was employed and ANCOVA was used for analyzing data. The result showed that concept mapping increased achievement and decreased anxiety for learning physical science. Results however did not indicate increased self- efficacy for teaching the physical sciences. The effect of concept mapping on achievement and interest is the main focus of this study. Anxiety will not be investigated and the subject matter is organic concepts in chemistry. However, the design and method of analysis used was adopted in this study.

Kola-Olusanya (1998) investigated the relative effectiveness of concept mapping and analogies in enhancing understanding of global warming and Ozone over depletion. The investigation involved 31 teachers and 39 students. The research finding showed that the teachers ranked concept mapping as being the better of the two strategies in bolstering student's performance in

environmental education. This study investigated if students' achievement and interest in organic concepts in chemistry will be enhanced by the method as indicated by the teachers. Furthermore, while the above study compared concept mapping with analogies, the present study compared concept mapping with simulation-game.

In a study on Ozone layer depletion and global warming with the task of determining the influence of three teaching strategies namely concept mapping, lecture/discussion and the use of analogies on the attitude of Nigerian science teachers and students towards the control of the above mentioned environmental problems, Kola-Olusanya (1998) used a total of 31 teachers (20 males, 11 females) and 39 SS II students (25 males and 14 females). According to the results obtained, the teachers used in the study confirmed that concept mapping enhances the understanding of the scientific problem which in turn permits the development of favourable attitude and interest. The present study concerned itself with achievement and interest. Moreover concept mapping and simulation-game were compared in terms of their effectiveness in enhancing achievement and interest.

The goal of Ezeugo and Agwagah (2000) was to determine the effect of concept mapping on students' achievement in Algebra in Nigeria. The study also investigated and determined the differential effect of concept mapping on the achievement of boys and girls in algebra. A total of 387 SS 2 students selected randomly were used for the study. The design was quasi-experimental, pre-test,

post-test and the data obtained was analyzed using ANCOVA. The results revealed that students exposed to the concept mapping technique achieved more in the algebra content than those who were not. Male students in the experimental group scored more than the females (also from the experimental group) in the achievement test. The above reviewed study was done in a unit in mathematics while the present one was done in organic concepts in chemistry. In addition they were carried out at different locations, Nsukka and Nnewi respectively. However, the design and method of data analysis used were adopted or employed in the present study.

In another development, Udeani (2000) conducted an investigative survey to explore the knowledge and use of concept mapping instructional strategy by science teachers in the class room. Seventy-one science teachers provided the data for the study through the use of a 35-item unstructured questionnaire. The major findings of the study include that 86% of the teachers responded that they were aware of the existence of the strategy but virtually all of them (91% approximately) could neither describe what it is or how to use it. It, therefore, follows that most of the teachers in the sample were aware of the strategy but do not have adequate knowledge of what it is and how to use it in teaching to enhance learning. This is rather frightening because the extensive gains to students' meaningful understanding and learning of difficult concepts are lost due to the teachers' lack of substantive knowledge about the teaching strategy. The present study afforded the teachers who participated in the study the

opportunity to learn more about the strategy and how to effectively use it to enhance achievement and interest.

Niccoll, Franciso and Nakhleh (2001) investigated the value of using concept mapping in general chemistry and more particularly, to see if concept mapping would produce a more interconnected knowledge base in students compared to ordinary instruction. The study was conducted in America and a total of 20 first year university students participated. The design of the study is quasi-experimental where 2 intact classes were used-one concept mapping and the other, the traditional lecture method. The researcher utilized a specially structured interview used at the end of instruction to determine the degree of interconnected need in a student's knowledge base. The researchers explained that structured interview was used instead of concept mapping. The result showed that the concept mapping group knew more concepts, more useful linking relationships and less negligible erroneous linking relationships than the non- concept mapping students. This study utilized first year university students and an adequate sample size. The present study utilized secondary school students. However the design of this study was employed in the present work.

The efficacy and potency of the concept mapping technique in improving senior secondary school students' achievement and retention in ecology was sought for by Dammole and Okoye (2004). A total of 137 students comprising 58 males and 79 females were involved in the investigation. The findings of the study showed that the experimental group performed significantly better than the

control group; thereby, showing that the concept mapping technique is very effective for meaningful learning. The present, however, investigated the efficacy and potency of concept mapping in enhancing achievement and interest in another subject-chemistry while the above reviewed work was done in Biology. However, the design and method of data analysis used were employed in this work.

In Cameroon, Nekang (2004:63) investigated the effect of concept mapping on groups of form V (final year secondary school) students' achievement and in elementary probability. The study also sought to find out the differential of concept mapping on the achievement of male and female students in probability. The result of the study showed that concept mapping enhances students' achievement and interest. The researcher recommended that teachers and students should apply the knowledge of concept mapping in every subject and at all levels of instruction from primary to tertiary levels of education. The study reviewed was carried out outside Nigeria and also in units in mathematics. The present work was done in Nigeria and also looked at effects of teaching methods on achievement and interest as was done in the reviewed work.

Looking at the works reviewed, some where done in other subject areas, some different locations including outside Nigeria. Some were done using undergraduate students, secondary school students and even teachers in some other instances. In most cases, concept-mapping were compared with other methods like lecture project etc. Literature also showed that some of the works

determined the importance of concept mapping with reference to anxiety reduction and attitude. The present compared concept mapping and simulation play strategies and investigated which of the two had a greater effect on the achievement and interest of students in the selected organic concepts in chemistry. While reviewing teaching strategies the researcher did not come across any study that compared the efficacy and effect of the two methods. Furthermore, effects of these methods on gender and school location in addition to interaction effects were also determined.

From the findings of the studies reviewed, the concept mapping technique was reported to be effective for achieving meaningful learning. Will it be equally effective in enhancing achievement and interest in organic chemistry? Will it be more effective than simulation-game? What will be the effect of these methods on gender and school location? The present study provided answers to these questions and many more.

Studies on Simulation Play

Abe (2003) investigated the effect of stimulation technique on some secondary students' achievement in English language learning. A total of 60 students randomly selected from J.S. III were used for the study. The research design was the pretest, post-test control group design in which the experimental group was taught some items of vocabulary through the use of simulation techniques. The control group was taught the same vocabulary items using the traditional lecture method. Data collected were analyzed using mean, standard

deviation, and t-test. The analysis of results revealed that the experimental group performed significantly better in both immediate and delayed recall than the control group. Abe (2003) findings suggest that using simulation games to teach may make learning remain permanent. Supporting this view, Rendel et al (1992) as cited in Akinsola & Animashaun (2007) claimed that the positive results obtained from retention over time favours the use of simulation-games and this may be because as games require the active participation of the students, the material being learned has a greater chance of being integrated into the cognitive structure of the individuals thus being retained.

Umo (2001) carried out an investigation on the effect of games on the achievement and interest of SS students in Igbo grammar. The effect of gender and location on the achievement and interest of the students taught using games were also determined. The sample for the study consisted of 197 J.S. II students drawn from eight secondary schools in the Nsukka Education zone of Enugu State. The samples were selected using the stratified random sampling technique. After the analysis of data generated, the study revealed, among other things, that there was no significant effect of the game the strategy on students' achievements in Igbo grammar. Secondly the study however, showed that there was a significant effect of game strategy on student interest in Igbo grammar. The present study also focused on the effect of simulation-game on achievement and interest. The effects of school location and gender were also determined. Will there be no significant effect of this strategy on achievement as reported by

Umo(2001)? This study answered this question. It can be seen clearly that Umo (2001) contradicted Aremu (1999) and Abe (2003) who declared a significant effect of simulation-game teaching method on achievement. Umo's finding on interest, however, is in agreement with the findings of the afore-mentioned scholars.

Akinosla and Animashuan (2007). Carried out a research in which they sought to determine the effect of simulation-games environment on students, achievement in and attitude towards mathematics in secondary schools. The design was quasi-experimental pretest, pos-test control group. The study utilized data collected from 177 senior secondary school students in Ogun, Nigeria. Data was analyzed using t-test and ANOVA. After data analysis, it was revealed that the use of simulation-games environment led to improved achievement and positive attitudes towards mathematics. He advised that teaches use simulation-games teaching methods as this will go a long way in motivating and sustaining students interest in learning. The present study investigated the effect of simulation-games on achievement and interest in a different subject area and unit-environmental concepts in chemistry. In addition, the interaction effects of this method gender and school location were also determined.

Aremu (1999) worked on the strategies for improving the performance of females in mathematics. The findings of the work showed that the use of simulation-games could be effective for the improvement of female pupils'

achievement in mathematics. Will it also enhance the achievement and interest of females in the organic concepts in chemistry? This study determined this.

Obeka (2007) investigated the effects of EPODEWALAND and power simulation-games on students' achievement and interest in some organic education concepts in geography. The study involves a total of 492 SS2 students. The design of the study was quasi-experiment, non-equivalent control group. Data were collected using organic problems Achievement Test (EPAT) and organic problems interest inventory EPII. While the data was analyzed using standard deviation, ANCOVA, Multiple Classification Analysis (MCA) and Test. Results of the analysis showed that teaching methods had a significant effect on students' achievement with those in the EPODEWALAD achieving higher than those in power simulation. Those taught with the lecture method achieved more. Other findings include that males performed better than females in all the groups in the treatment and control. Significant interaction effects were also reported between teaching methods, achievement, ability and gender respectively. This study is related to the present one in the sense that both looked at the effect of teaching method on achievement. While the reviewed study focused on organic problems in geography, the present study focused on organic concepts in chemistry. However, the design and methods of data analysis used in the reviewed study were also applied in the present.

Longjohn (2009) studied the effect of the games method of teaching on students' academic achievement in chemistry. The design of the study was the pre-test, post-test quasi-experimental. Four intact classes consisting of a total of 140 SSI students (72 boys and 78 girls) were randomly selected from three local Government Areas in River State for the study. It was guided by 2 research questions and three hypotheses. The method of data analysis was descriptive statistics and ANCOVA. Results showed that the group taught using the game method performed significantly better than the group taught using the lecture method. Other findings include that girls performed significantly better than boys and again, three was no significant interaction effect of gender and teaching method on students' academic achievement. The present study also investigated the effect of simulation-game teaching method but on a different unit in chemistry other than the one studied above (the 1st 20 elements of the periodic table). The present study compared the simulation-game method with another meta-cognitive teaching strategy to ascertain which of the two will enhance achievement and interest more. The present study also investigated the influence of gender on achievement and interest. The method of data analysis in the above study was also employed in the present study. However, Windale, Hudson and Smith (1995) in a study on teaching and learning approaches in science education discovered that out of the 300 science teachers involved in the study, 68% of them indicated that they had never used the simulation-game strategy in teaching science.

Studies on interest and achievement

Despite the indisputable importance of interest and achievement to learning relatively few studies have investigated the effect of teaching methods and techniques on the development of students' interest and achievement (Osuafor 2001).The goal of Obodo (1990) was to investigate the effect of three teaching models on the achievement, retention and interest of JSS students in some mathematical concepts. The three models are: target, task, delayed formulization task and expository models. The design was a pretest post test experimental. A total of 447 JSS 2 students randomly selected from four schools in the Enugu Education Zone were used for the study. Means, standard deviation and ANOVA were the statistical tools employed during data analysis. Results revealed that (a) on the average the three models (target task, delayed formalization and expository) were effective in enhancing achievement and retention. (b) The models were not significant factors in terms of students' interest in the concept algebra. (c) The urban students, however, showed more interest than their rural counterparts. The present study was equally experimentally designed and focused on the effect of teaching methods on achievement and interest. Unlike the above reviewed study effects on retention will not be investigated and the teaching methods used were concept mapping, simulation-play and lecture methods. Secondly, while the above reviewed study determined only the effects of school location (Rural-Urban), the present study

in addition to school location also investigated the effect of gender on achievement and interest.

In another development Nworgu (1990) investigated the effects of resources materials types on students' cognitive achievement, retention and interest in integrated science. A pre-test, post-test quasi-experimental design involving three intact groups was employed. Instruments for data collection were Achievement and Retention in Integrated Science (ARTS) and Integrated Interest Inventory Scale (ISSIS). The method of data analysis include a 3 x 2 ANOVA. A total of 420 JSS 1 students in Nsukka Urban provided the data for the study. Results obtained revealed that resources materials type was consistently significant to all the three dependent pressures, namely-achievement, retention and interest. Standard resource materials proved superior with reference to retention. Locally improvised resource materials proved superior in enhancing interest towards integrated science. The design and method of data analysis of the above reviewed study were adopted in the present study. However, while achievement and interest were also studied, retention was not investigated.

Osuafor (2001) studied the effect of field trip and role play on pupil's achievement and interest in environment concepts in primary science. A quasi-experimental, non-equivalent control group design was used. A total of 490 subjects in primary six from four randomly sampled schools (2 Urban, 2 Rural) were involved in the study. Data analysis was done using mean, standard

deviation, ANOVA, MCA and Scheefs test. Major findings of study include that:

a. Teaching method had no significant effect on achievement but showed significant difference on the mean interest scores of students.

b. The lecture field trip method was most effective on cognitive achievement and interest of pupils.

c. Pupils in the rural schools performed significantly better than their urban counterparts both in achievement and interest. The design and methods of data analysis of this study were adopted in the present investigation. In addition while the study under review used primary school pupils, the present study used secondary school students who offer chemistry.

Njoku (1997) investigated the effect of practical work under different sex groupings on students' skill acquisition and interest in chemistry practical activities. The design was the randomized post-test only control group. The study was carried out in the Enugu Education zone of Enugu State. The sample comprised 170 SS II chemistry students in two co-educational schools. Data was collected using three instruments namely:

a. A 5- point, 57-item chemistry practical skills Rating scale (CPSRS);

b. A 4-point, 36 item chemistry laboratory activities interest scale (CLAIS) and

c. A chemistry practical Test (CPT). The methods of data analysis employed were mean, standard deviation and Analysis of Variance (ANOVA). Findings

of the study are; the female group had a significantly higher mean score in chemistry practical skills than the male and mixed sex groups. Secondly, sex grouping and school location had a significant interaction effect on students' acquisition of chemistry practical skills. The female groups performed best in urban location while male sex group performed worst in the rural location. The present study will adopt the dependent and independent variables considered in the above reviewed study though in a different unit in chemistry and also using teaching strategies, different from the ones used in the study under review.

Studies on Influence of Gender on Interest and Achievement

Gender is one of the factors interacting with achievement and studies on it have remained unresolved as findings from some research works have shown contradicting evidences in academic achievement of students due to gender. While some researchers found that male students have a higher achievement than females, others opined that the reverse is the case while yet another group found no significant difference in the performance/ achievement of males and females. This inconsistency in the research findings according to Ezeudu (1995) has caused a lot of concern to educationists.

Ukwungwu (2002) carried out a meta-analysis of empirical studies on gender related difference in achievement and interest in the sciences. Two research questions and eight (8) hypotheses guided the study. The study however reported that the magnitude gender difference in achievement and interest in science (chemistry) was in the favour of the males. He advised that the females

require greater attention during instruction as a pedagogic implication of teaching chemistry using process based approach.

Mari (2002) already reviewed also discovered that gender influenced the performance of students with the males being at advantage when he investigated the Gender Related Differences in Acquisition of Formal Reasoning Schemata.: Pedagogic implication of Teaching Chemistry using process based approach.

Joseph (1996) investigated Gender Differences in Senior Secondary School Chemistry Performance in Akwa-Ibom State. A sample of 380 SSIII chemistry students drawn from three different secondary schools provided the data for the study. The schools were selected through stratified random sampling. The researcher used a chemistry achievement test which was administered on the students. The results of the investigation revealed a significant gender difference in the performance of the students in favours of the males. Similarly, Okebukola (1986), Wasagu (1995), Obioma and Ohuche (1981) all in Ukwungwu (2002) observed that males perform better than the females in the physical sciences.

However, Gesell (1984) as cited in Ezeudu (1995) pointed out that before II years plus, girls perform better in mathematical operations than boys of the same age but also indicated that this advantage ceases after eleven. This information notwithstanding, one cannot quickly conclude that gender differences in science achievement have a relationship with the age of the subjects under study. The reason may be got from the findings of Itusokor

(1985) as in Ezeudu (1995) where he compared the performances of male and female Nigerian adults on the Wechsler Adult Intelligent Scale (WAIS) and found the males performing better than the females in both full scale 1.Q. and the verbal subtests. Ittusokor (1987) as cited in Ezeudu (1995) also found almost identical results with boys and girls in secondary schools. Okeke (1990) cited in Isa(2005) also reported that females perform far below the males in science technology, mathematics and related fields.

However, Williams (1989) as cited in Njoku (1997) stated that females are not inferior to males in intellectual capability since there is no biological proof to that effect. Igboegwu(2005) opined that there is nothing inherent in the physical sciences that causes the observed differences in the performances among males and females. Njoku(1997), therefore, suspects that there most be other factors aside the nature of the subject and sex which are responsible for the superior performances of males. Levin(1987) as in Njoku(1997) pointed out that these observed differences in the performances of males and females can be attributed to unequal science experiences and training of the sexes. They are of the view that female students' underachievement is a problem of affective readiness which is indicated in their lack of self confidence, interest and low aspirations and not a matter of incompatibility as such.

Isa (2005) also reported that the actual learning experiences provided for the boys and girls beginning from primary school are not in favour of girls with respect to science. According to her, during the craft lessons in the primary

schools, both the males and females can be affected by the teaching and learning styles.

As the impasse remains unresolved, a more recent study was carried out by Okwo and Otubah (2007) on the topic: Influence of Gender and Cognitive Style on Students Achievement in Physics Essay Test, in which a total of 87 SS2 students (37 boys and 50 girls) were involved. Two instruments were used for data collection; they are the Group Embedded Figure Test (GEFT) and the Physics Achievement Test (PAT). Stepwise multiple Regression Analysis and F-test were used for data analysis. The results of the study showed that gender and cognitive style are individually and jointly significant factors influencing students achievement in the favour of the males thus confirming the earlier views of so many researchers among whom are Ezeugo & Agawah (2000), Ekwueme & Umionyang (2006) that gender is a relevant factor in achievement. This, according to Ezeudu (1995), may be due to the fact that females and males differ in a number of sensory and perceptual capacities. She suggested that aptitudes for male and females can be used to explain more on the differences. According to Ezeudu (1995), based on the results of the works of Hutt (1972) on the aptitudes of males and females, Itsukor and Afe (1989) on aptitude and cognitive ability, Kilausmeher & Wiesman (1964) on divergent and convergent thinking (all in Ezeudu 1995) one can then conclude that aptitude may be responsible for gender differences, in the achievement of males and females.

However, aptitude cannot be the only influencing factor because a gender difference in achievement is not innate as Williams (1989) cited in Njoku (1997) had earlier stated. Other factors like curriculum content and methods of instruction may have elements of gender stereotypic and all of these may be responsible for the inconsistent results of the influence of gender on the achievement. Concept mapping and simulation-play instructional strategies by their nature do not contain any elements of gender stereotypes. This implies that any effect they impact on achievement and interest may be attributed to aptitude. This study, therefore, investigated the influence of gender on achievement and interest of students exposed to the above mentioned strategies. The results obtained may lay to rest the conflicting gender controversies associated with science and technology. Therefore, this differentiation simply reinforces girls' negative attitude to more sophisticated technology.

On the contrary, other researchers like Ekwueme and Imoinyang (2006) proved that females perform better than the males. Umoinyang and Ekweuene (2006) investigated gender in Cross River State. A random sample of 353 SS3 students from 12 secondary schools in Calabar metropolis was used in the study. The design of the study was the ex-post facto research design. Data was collected using the questionnaire Gender and Mathematics Learning Factors questionnaire (GMLFO). Data was analyzed using t-test and chi-square test statistics. Results of the analysis revealed that girls have a significantly higher (more positive) attitude towards mathematics. The research found this surprising

as mathematics is generally acclaimed as a masculine subject. The present study, therefore, made a further investigation on the influence of gender on achievement and interest of students (though in another subject-chemistry) to ascertain if this female superiority will repeat itself. Though the studies in favour of females achieving more than males are very few, it is, however, surprising because some of the above mentioned results were obtained from adults and secondary school students whose ages have exceeded eleven when, according to Gesell (1984), the males are supposed to be taking the lead.

In yet another contradicting development, Dammole and Adeoye (2004), while investigating the effect of the concept mapping technique on senior secondary schools students' achievement and retention of ecology concepts, discovered that there is no significant difference in the achievement of male and female students exposed to the same teaching strategy. Aiyedun (2000) also showed that achievement does not depend on sex when she investigated the influence of sex differences of students on achievement. Aiyedun (2000) and Dammole et al (2004) seem to be further confirming the views of Daramola (1983), Orji (1984) and Inomesia (1989) all in Aiyedun (2000), that there is no statistically significant difference in the performance of males and females. While in another development Agbi (2006) agrees with an earlier discovery of Udofia (2002) and views of some researchers that gender has no significant effect on the achievement and interest of students.

Summary of Literature Review

Consequent upon the fact that chemistry teaching should involve creative ways of assisting the learner to learn with ease and acquire self reliant skills, the literature review of the study on the comparative effectiveness of concept mapping and simulation play as advanced organizers on the interest and achievement of students in organic chemistry was presented under the following major sub-headings: Conceptual framework, theoretical framework, theoretical studies and empirical studies. This composed the variables focused on in the study.

Indeed, there was enough evidence from the studies to show that modern scientific and technological advancement, and indeed all the sciences, rely so much on chemistry with greater emphasis on the principles of the products of the living things within the environment. It was also established that this aspect of curriculum has not been properly taught as to yield the desired result which include inculcating self-reliant skills, positive scientific attitudes and awareness, research oriented skills and values in the learners which would have resulted from enhanced achievement and interest in the organic chemical concepts. Inferentially, the teachers, curriculum planners and examination bodies do not lay enough emphasis on the innovative teaching strategies to bring them to prominence; hence, the recorded poor results and prevalent poor scientific attitudes.

The review also revealed the meta-cognitive innovative strategies that allow active the participation of learners in the entire process of teaching. Learning enhances performance in all aspects of education. Concept mapping and simulation play are some of the strategies reported to be very effective in promoting learning, especially in technology and science education concepts (UNESCO-UNEP, 1988). Surprisingly, very few studies employed the use of concept mapping and simulation play on organic concepts in chemistry.

Furthermore, the review revealed that the two strategies are not widely used by teachers, especially in Nigeria (Okebukola, 1992; Ahove, 1998; Kola-Olusanya, 1998; & Udeani, 2000), instead the conventional lecture method which does not have a lasting effect on the learners, still dominates our classrooms. Teachers, according to Ahove(1998) & Udeani (2000),attributed this dominance to the little time available for the large volumes of work. However, Okebukola (1992) attributed it to inexperience and impatience on the part of teachers to prepare these maps and games. The review showed that interest is an indispensable construct for achievement. It was established that teaching methods employed by teachers directly affect students' interest and achievement.

On the influence of gender on students' achievements, literature showed conflicting report, on which of males and females achieve better; therefore, further research is needed as some other variables like environmental influence,

parental guidance, family orientation, intelligent quotient, etc. could influence gender on achievement.

Further, on the influence of methods and teaching strategies on interest and achievement, literature revealed that methods and strategies of instruction influence students' interest and achievement, but the effectiveness of the methods and strategies on specific scientific concepts were not found in the literature reviewed.

Also, organic and inorganic substances form major components of our chemical environment, and although organic substances such as sugar, starch, alcohol, resins, oil, indigo, etc. had been known from the earliest times, very little progress in their chemistry was made until about the beginning of the eighteenth century (Finar, 2008:1). However, Finar (2008:2) recorded that the differences between the two classes of compounds have been disproved, and described organic chemistry as the application of fundamental principles, and consists of a large variety of methods and reactions which appear isolated, and consequently only to be learnt by heart.

In recent times, these methods and reactions have not been properly propagated to assist the learners toward gainful application. This could be attributable to the ineffectiveness of teaching methods. There is, therefore, the need for effective ways of teaching, and thus the need for a study of the effectiveness of concept mapping and simulation play on the interest and

achievement of students in organic chemistry. Hopefully, the result of this study will help to fill the gaps in the studies reviewed.

CHAPTER THREE

METHOD

The detailed description of the method used for this study is presented in this chapter under the following headings; the design of the study, area of the study, population, sample and sampling technique, experimental procedure, control of extraneous variable, instrument for data collection, reliability and validation of the instrument, method of data collection and analysis were discussed.

Research Design

The design of this study was quasi-experimental as there were no randomization of the research subjects. When the subject are not randomized, the design is not a true-experimental design but a quasi-experimental design. Thus, the specific design (quasi-experimental) used for the study involves pre-test and post-test of non-equivalent groups involving 2 experimental groups. The design is shown in figure 1.

Figure 1: Design of the Experiment

Group	**pre-test**	**Treatment**	**post-test**
Concept Mapping (experimental)	O_1	X_1	O_1
Simulation Game (experimental)	O_2	X_2	O_2

Area of the Study

The area of study was the Ogidi Education Zone of Anambra state. The Ogidi Education Zone is one of the six education zones in Anambra state. Others are Awka, Aguata, Onitsha, Nnewi and Otuocha Zones. The Ogidi Education Zone is made up of three local government areas (Idemili North, Idemili South and Oyi). The three local government areas have similar cultures and traditions and dialects. The area is at about the center of Anambra state, and almost shears boarders with the three major cities in the state- Awka, Nnewi and Onitsha. The area is semi-urban as it experiences moderate traffic flow, good road networks, few modern buildings. Modern amenities such as boreholes, recreation centers, restaurant and hotels are springing up in this area. With less commercial influence, it can be considered conducive for academic activities. According to records from Ogidi zonal education office, there are 40 government owned secondary schools in the zone distributed as follows: Idemili North,16; Idemili south, 13; and Oyi, 11. Also, the Zone comprises 25 co-educational and 15 single-sex schools. The distribution of schools in the Zone by local government areas and school types is shown in Appendix I

Population of the Study

The population is made up of all the seven hundred and one(701) senior secondary three (SS3) chemistry students found in the 40 government owned secondary schools in the Zone. Idemili North LGA comprises 322 students, Idemili South LGA,192 students, and Oyi LGA,187 students. These students are

made up of 318 boys and 383 girls. The choice of SS3 chemistry students was based on the fact that the topics selected for the study (Esterification and Saponification) are part of the SS 3 scheme of work for chemistry (NERDC, 2005).

Sample and Sampling Technique

The sample consists of 129 SS3 chemistry students in the Zone. Simple random sampling technique was used to select four co-educational schools from the 25 in the zone, two from Idemili North LGA out of its 12 co-educational schools and one each from Idemili South and Oyi Local Government areas comprising 5 and 8 co-educational schools, respectively. The selection of only co-educational schools was to provide classes where boys and girls work side by side under the same teacher and within the same classroom condition. It also guarantees thorough study, and avoidance of interclass discussion.

From each of the four schools selected, one intact class was chosen. The intact classes were also chosen by simple random sampling in cases where more than one science class existed. Two intact classes were assigned to experimental group E_1 (concept mapping group), two to experimental group E_2 (simulation play group). The distribution of samples is shown in appendix H.

Instruments for Data Collection

Two research instruments: Organic Chemistry Students' Interest Inventory (OCSII) and Organic Chemistry Students' Achievement Test (OCSAT) were used for data collection.

1. Organic Chemistry Students Interest Inventory (OCSII)

A 30-item OCSII adapted by the researcher from vocational interest inventory developed by Ifeakor (2005) was used for this study. The original inventory which is on four point scale of like very much(LVM), like (L),dislike(D), and dislike very much (DVM) was modified to a five point response type of:

1. Strongly agree (SA),
2. Agree (A),
3. Undecided (UN),
4. Disagree (D), and
5. Strongly disagree (SD),

The response scale was modified to enable the respondents to express their level of agreement with the statements which aims at eliciting the students' levels of interest.

See Appendices B and C

The instrument was administered to the 129 SS 3 chemistry students before and after treatment. The result obtained was used to ascertain the students' level of interest in organic chemistry.

2. **Organic Chemistry Students' Achievement Test (OCSAT)**

The CAT is a 40-item multiple choice test (questions) constructed from the topics taught. The topics were saponification and esterification. The following sub-topics and table of specification guided the construction of the OCSAT. The table

of specification derived its weightings from the emphasis given to the sub-topics in the Chemistry texts(Ababio, 2013). Based on the performance objectives for fats and oils as given by NERDC(2011), definition, identification, stating the properties, carrying out tests, and uses were classified for comprehension and knowledge levels. While differentiating, explaining, with equations and other applications were classified for applications and other higher order questions.

They are:

1. Concept of esters,
2. Preparation of esters using organic acids and alkanols,
3. Properties of the esters,
4. Uses of esters,
5. Concept of salts of carboxylic acids,
6. Preparation of soaps using organic acids and alkalis,
7. Properties of soaps of organic acids, and
8. Uses of soaps.

Table 1: Table of specification for the construction of organic chemistry students' achievement test (OCSAT)

	Content	Know-ledge	Comprehension	Application	Other Higher order Questions	Total	%
1.	Concepts: Esterification , Saponification	4	2	2	2	10	**25%**
2.	Preparation of Esters and Soaps using organic acids, Alkanols and Alkalis	4	3	3	2	1 2	**30%**
3.	Properties of salts of Alkalis and alkanoates of Organic acids	2	3	3	2	10	**25%**
4.	Uses of Esters and Soaps.	2	2	2	2	8	**20%**
	Total	12	10	10	8	40	
	100%	**30%**	**25%**	**25%**	**20%**		**100%**

The table of specification ensures content validity of the test items. In this table, four sub–topics taught under Esterification and Saponification respectively were written horizontally. The vertical axis of the table shows the weightings for the objective levels based on the proportion of knowledge, comprehension, application and higher cognitive Skills for performance objective in the unit of study in the curriculum.

The weightings reflected the emphasis placed on the objectives and topics during instruction. Example: Knowledge has 30% of the content and comprehension 25%.

Validation of the Instrument

To ensure the construct validity of the OCSII, the research purposes, scope, research questions and hypotheses were given to two experts in science education; an expert in measurement and evaluation and two experienced chemistry teachers for validation.

The OCSAT was given to an expert in measurement and evaluation and two chemistry teachers from secondary schools. The teachers possess Bachelor's of Science degrees in Chemistry education, and have taught and marked the senior school certificate Chemistry for at least 10 years. They were requested to determine the adequacy of the items for cognitive, affective and psychomotor levels of the chemistry students. They were also requested to modify any ambiguous statements. Based on their corrections, some items were removed which reduced the items from 60 to 40. These are shown in appendices D and E.

Reliability of the Instrument

The researcher administered the final OCSII on thirty-five (35) SS3 chemistry students in a school who are not part of the sample of the study. Using Cronbach's Alpha reliability technique, the scores were analysed. Cronbach's reliability coefficient was found to be 0.72. This result was good for the internal consistency of the instrument as suggested by Akuezuilo & Agu (2009).

To determine the reliability of CAT, 35 copies were administered on 35 students who were not part of the sample but were equivalent to the group used for the study. The same was reordered in coloured paper and administered again on those students. The test-retest reliability coefficient was found to be 0.82 using Pearson-product moment correlation coefficient. Thus the instrument was considered reliable enough for the study as suggested by Akuezuilo & Agu (2009).

Validation of the Instructional tools (Lesson plans)

The lesson plans used to teach each group were given to two colleagues of the researcher and three experienced chemistry teachers in secondary schools. The teachers teach SS3 students and have marked the SSCE Chemistry for at least ten (10) years. They were asked to comment on the level of suitability of the language and clarity of expressions used. Also, they assessed the content coverage and adequacy of the students' activities to the lesson contents. Their comments and suggestions were used to modify the lesson plans.

Experimental Procedure

This study involved two groups of subjects. These were concept mapping group (CMG) and Simulation play group (SPG). Before the experiment commenced, the researcher trained the research assistants (chemistry teacher of each school) on how to use the instructional tools (lesson plans). The training lasted for 12 days (3days for each assistant as distance could not allow for joint training). The training programme is shown in appendix L, and the instructional tools presented in appendix J. The instrument for data collection was administered on the students

before treatment. Students' scores in the first administration served as the pre-test scores for the study.

The teaching lasted for six weeks for all the groups. The students were taught by their regular teachers. This was to avoid experimenter's bias. The different treatment groups were taught the same topics using the appropriate instructional tools (lesson plan) for each group.

For the experimental group (E_1), Concept mapping, the students were taught the same unit conventionally prior to the concept mapping exercise. The teacher then gave a brief explanation of what concept mapping is, and how the maps are constructed, using the concept maps constructed by the researcher. The students were instructed to construct their own maps as the lesson proceeded, and also after the lesson, under the supervision of the teacher. The concept maps are shown in appendix F.

For experimental group (E_2), Simulation-game, the students were taught the same unit conventionally prior to the game exercise. Pre-game handouts were given to them some days before the actual play for them to read at home and get prepared for their roles. They were also told in advance to provide the materials (costumes) needed for the play.

On the treatment day, the students were divided into groups for their different roles after a brief introductory lesson. Role cards already numbered were distributed to them with detailed explanations of their roles after which the simulation game exercise started. The simulation-play exercise was followed by a

debriefing session after which a general discussion followed to highlight the important parts in the exercise.

Pre-play handouts and the simulation game structure are shown in appendix J (pages 192-206). Post-tests were administered at the end of treatment.

Control of Extraneous Variables

The following measures were adopted to control some of the extraneous variables in the study:

i. **Initial group Difference:** Due to the nature of the administrative set up in the schools, there was no randomization for the research subjects because the students were already organized in classes. ANCOVA was used for data analysis as the study adopted the non-randomized group design where the pretests scores are covariates of the posttest scores.

ii. **Experimenter's Bias:** To avoid bias in the present study, the regular chemistry teachers in the schools selected for the study where trained and used. The researcher monitored these teachers so as to ensure that they effectively adhered to the instructional tools prepared by the researcher.

iii. **Teacher Variable:** When different teachers are involved in an experiment, the problem of teacher variable arises, since different teachers possess different standards in terms of knowledge of the content and methodology. In order to control this variable in the present study, the researcher prepared instructional tools (Lesson plans) on the topics which were used to handle

each group. The researcher trained the teachers on how to effectively use these lesson plans.

iv. **Variability of instructional Situation:** Homogeneity of instruction across groups were ensured as follows:

a. The researcher trained all the teachers on the instructional procedures involved.

b. These teachers were directed to strictly follow the detailed lesson plans provided.

c. All the groups were taught the same topics and within the regular periods allotted to chemistry on the school timetable.

v. **Effects of Pre-test and Post-test:** In order to minimize influences of memory and forgetfulness, the time lag of six weeks between the pretest and post-test was considered neither too short nor too long. This relatively short experimental duration minimizes the effect of interaction. The pre-test items were withdrawn from the students at the end of the pre-test. The pre-test items were also renumbered and produced in different coloured question papers before being used for the post-test.

vi. **Training of Teachers:** Teachers were trained to enable them acquire the necessary competencies required to effect the implementation of uniform experimental conditions. The teachers also have similar qualifications and number of years of experience. The training programme lasted for 3 days for each assistant.

vii. **Class Interaction:** To solve the problem of inter-class discussion among the students, one intact class only were used in each the selected schools

viii. **Institutional effect:** The effect of institution was controlled by choosing schools that are far from each other. Also, the students were not made to know that some other schools are involved in the study or the schools that are involved. The teachers were trained and uniform instructional tools used.

Scoring of the items

Scoring of OCSII:

In the OCSII, Strongly Agree, Agree, Undecided, Disagree and Strongly Disagree were rated of 5,4,3,2 and 1 respectively. Therefore, any group with a mean score of 90 and above could be considered to be of high interest in organic chemistry while a mean score below 90 could be considered to be of low interest.

Scoring of the OCSAT:

OCSAT was scored using the marking scheme shown in appendix E, which was validated by the experts and the chemistry teachers. Students' correct responses were scored one mark, and incorrect responses zero. The total number of correct responses formed the OCSAT score. Scores of 1-20 were rated as low score while scores of 21-40 were rated as high score. 40 marks was the maximum score.

Method of Data Analysis

The research questions were answered using means and standard deviations. If the value of standard deviation (SD) was small, there was little variability and the majority of the scores were tightly clustered around the mean. If the SD was large,

the scores were more widely scattered above and below the mean. The hypotheses were tested at 0.05 alpha levels, using Analysis of Covariance (ANCOVA). The ANCOVA was used to test all the null hypotheses based on the fact that the study adopted the pre-test-post-test non randomized control group design, where the pre-test scores were used as a covariate of the post-test scores. ANCOVA was preferred because it removes the bias that might have resulted from an intact group whose equivalence had not been determined.

CHAPTER FOUR

DATA ANALYSIS AND PRESENTATION OF RESULTS.

The chapter deals with the analyses, interpretations and presentation of data based on the research questions and hypotheses that guided the study. The data presented in form of tables provides the answers to research questions and information for testing the hypotheses.

Research question 1:

What is the difference between the mean gain interest scores of male and female students taught organic chemistry using simulation play and concept mapping strategies?

From table 2 under simulation game strategy, the males recorded 125.03 to appear better than the females with a score of 117.17. Also in concept mapping strategy, the males proved better with 115.90 against the females' 115.75.

Research question 2:

What is the difference between the interests of students taught organic chemistry using simulation play and concept mapping as measured by their mean gain interest scores?

In order to answer research question 2, mean score and standard deviation of students were calculated and presented in table 2 which shows the dependent variable mean gain interest scores (**descriptive statistics).**

Table 2:

TEACHING METHODS, SEX, AND MEAN OF STUDENTS ON OCSII

Teaching method	Sex	Mean	Std. Deviation	N
Simulation Play	Male	125..03	5.96	31
	Female	117.17	9.56	29
	Total	121.23	8.78	60
Concept mapping	Male	115.90	5.96	30
	Female	115.64	7.47	39
	Total	115.75	6.80	69
Total	Male	120.54	7.49	61
	Female	116.29	8.39	68
	Total	118.30	8.23	129

The simulation game group recorded a mean of 121.23 and standard devia 8.78. The concept mapping group recorded a mean of 115.75 and standard deviation of 6.81. From the results, there are differences in mean gain scores and standard deviations of students taught organic chemistry using simulation play and concept mapping as measured by their mean scores.

Research question 3:

What is the difference between the mean gain interest scores of chemistry students taught organic chemistry with simulation play and concept mapping instructional strategies?

Table 4 shows that male students taught organic chemistry have a mean score of 120.54 and standard deviation of 7.49, while the females recorded a

mean of 116.29 and standard deviation of 8.39. In order to make a decision on the interest of male and female chemistry students, hypothesis 2 was tested.

Research Question 4:

What is the difference between the mean gain achievement scores of male and female students taught organic chemistry using simulation play and concept mapping strategies?

From table 3, under simulation play strategy, the males were better with a score of 22.71 as against the females' 20.28. in concept mapping strategy, the males were still better with the mean score of 17.97 as against the females' 17.72.

Research Question 5:

What is the difference between achievement scores of students taught organic chemistry using simulation play and concept mapping as measured by their mean gain chemistry achievement test scores?

In order to answer research question 5, mean scores and standard deviations of students in their mean gain achievement scores were calculated and presented in table 3 as dependent variable mean gain achievement scores (descriptive statistics).

Table 3: Teaching methods, sex, and mean of students on OCSAT

Teaching method	Sex	Mean	Std. Deviation	N
Simulation Play	Male	22.71	4.91	31
	Female	20.28	4.68	29
	Total	21.53	4.91	60
Concept mapping	Male	17.97	4.68	30
	Female	17.72	4.80	39
	Total	17.83	4.71	69
Total	Male	20.38	5.32	61
	Female	18.81	4.88	68
	Total	19.55	5.14	129

From table 3, the mean achievement scores of students taught with simulation play, concept mapping and lecture methods were 21.53 and 17.83 with standard deviation of 4.92 and 4.72 respectively. This shows that students taught with simulation play have higher mean achievement scores than those taught with concept mapping. In order to make a decision on whether there is a significant difference on the achievement of students taught with the two methods, hypothesis 4 was tested.

Research Question 6:

What is the difference between the mean gain academic achievement scores of male and female students taught organic chemistry using simulation play and concept mapping as measured by their mean gain Chemistry achievement test scores?

Table 3 shows that male students recorded a mean score overall of 20.38 and standard deviation of 5.33 to appear better than the females who recorded a mean score overall of 18.81 and standard deviation of 4.88.

Hypothesis 1:

HO_1: There is no significant difference in the mean gain chemistry interest inventory scores of students taught with simulation play and concept mapping.

Table 4: Teaching methods, gender, and interactions of teaching methods and gender on interest.

Source	**Type III sum of square**	**Df**	**Mean square**	**F**	**Sig**
PRETEST (covariate)	66.03	1	66.03	1.22	.271
TM	965.15	1	965.16	17.83	.000
SEX	526.78	1	526.78	9.73	.002
TM.SEX	481.00	1	481.01	8.89	.003
Error	6708.74	124	54.10		
Total	1814077.00	129			
Corrected Total	8665.21	128			

From the dependent Variable computations on Interest(Test of between subject effects) in table 5, a significant effect was observed for teaching methods, $F(1,124)=17,83$ $p<0.05$; therefore, the null hypothesis is rejected. This means that a significant ($p<0.05$) difference exists between students taught with simulation play and concept mapping. Inspecting the means in table 3, SG group

has higher post test mean interest score of 121.23 over the concept mapping group with post test mean interest of 115.75.

Hypothesis 2:

HO_2: There is no significant difference in the mean gain interest scores of male and female students.

Table 4 reveals that gender was a significant factor on students' overall interest scores on OCSII. $F(1,124)=9.74$, $p<0.05$. Therefore, the null hypothesis was rejected. This implies that male students' interest is significantly different from the females using SG and CM methods.

Hypothesis 3:

HO_3: There is no significant interaction effect between teaching method and gender on students' interest as measured by their mean gain chemistry interest inventory scores.

Table 4 explains hypothesis 3. 1t reveals that there was a significant interaction effect of teaching method and gender on students' interest. $F(1,124)=8.89$ $p<0.05$. The null hypothesis was rejected. On inspection of figure 1, males have higher mean interest of 120.54 while the females recorded 116.29. Therefore the null hypothesis was rejected. See appendix Q for the plot of the interactions which is disordinal.

Hypothesis 4:

HO_4: There is no significant difference in the mean gain achievement scores of students taught organic chemistry with simulation play and concept mapping.

Table 5: Teaching methods, gender, and interactions of teaching methods and gender on achievement.

Source	Type III sum of square	Df	Mean square	F	Sig
PRETEST (covariate	300.47	1	300.47	14.61	.000
TM	570.54	1	570.54	27.74	.000
SEX	23.88	1	23.88	1.16	.283
TM.SEX	44.92	1	44.92	2.18	.142
Error	2550.57	124	20.57		
Total	52688.00	129			
Corrected Total	3381.92	128			

a.R Squared = .246(Adjusted R Squared = .221)

From table 5 presents computations on dependent Variable on achievements **(Test of Between Subjects Effects**: $F(1,124)=27.74$, $p<0.05$. A significant effect was observed for teaching methods. Therefore the null hypothesis is rejected. From pair wise comparison of mean and on inspection, SG has a mean of 21.53 while CM has a mean of 17.83. Therefore SG is considered more effective than CM.

Hypothesis 5:

HO_5: There is no significant difference in the mean gain chemistry achievement scores of male and female students.

Table 5 reveals that gender was not a significant factor on students' overall achievement scores on POSTCAT. $F(1,124)=1.16$, at $p=0.283$, $p>0,05$. Therefore, the null hypothesis was accepted. This means that male students' achievement is not significantly different from the females. Any difference in the mean may be due to sampling error or method and not due to gender.

Hypothesis 6:

HO_6: There is no significant interaction effect between teaching methods and gender on academic achievement of students in organic chemistry as measured by their mean gain chemistry achievement test scores.

Table 5 explains hypothesis 6. It reveals that there is no significant interaction effect between gender and teaching methods on achievement as measured by their mean gain achievement scores. $F(1,124)=2.18$, at $p=.142$, $p>0.05$. This shows that the achievement of student in relation to the method is not influenced by gender. Therefore, the HO_6 is accepted.

Summary of Major Findings

The major findings in this study are as follows:

- The use of simulation play, and concept mapping as teaching methods were significant factors on the students overall interest and achievement.

- There was a significant difference between the effectiveness of simulation play and concept mapping on students' interest and achievement in organic chemistry.
- Gender was a significant factor on the overall interest of the students.
- Gender was not a significant factor on the overall achievement of the students.
- Significant interaction effect of teaching methods and gender was not detected in the students' achievement.
- The interaction due to teaching method and gender on the students' interest was significant.

CHAPTER FIVE

DISCUSSION OF RESULTS, CONCLUSION, IMPLICATIONS, RECOMMENDATION AND SUMMARY.

This chapter presents the interpretation and discussion of results presented in the previous chapter.

The discussion is organized under the following:

- The effectiveness of teaching methods on students' interest in organic chemistry,
- The effectiveness of teaching methods on students' achievement in organic chemistry,
- The influence of gender on students' interest in organic chemistry,
- The influence of gender on students' achievement in organic chemistry, and
- Conclusion, educational implications, recommendations, limitations of the study, suggestion for further research, and summary.

The Effectiveness of Teaching Methods on Students' Interest in Organic Chemistry.

The study revealed that students taught with the simulation play m

showed significantly greater interest than those taught with concept mapping. The trend of higher interest of the simulation play group could be as a result of

the involvement of the students in the entire activity of the learning process and the preparatory activities provided by the SP method which aroused the students' interests in the learning of organic chemistry with much ease than the CM

Furthermore, the rehearsals and other preparatory activities provided by the SP method were unique approaches, which made for greater interest of the SP group. The above finding is consistent with those of Osuafor (2001), Imoko (2004), Asiyai (2005), Agbi (2007) and Adesoji (2008).

Further, the significant difference in the interest of students taught with simulation play and concept mapping methods at $p<.001$ shows that SP is more effective. This could be traced to the boredom expressed by the students at certain stages during the construction of the Concept maps as there is no stereotype concept map for any concept.

The Effectiveness of Teaching Methods on Students' Achievement in Organic Chemistry.

The issue of whether SP or CM is more effective on students' achievement was resolved in this study. The findings revealed that the mean achievement scores in the Chemistry Achievement Test were higher with SP group (25.53) than CM group (17.83). Then differences in the scores of the two groups were confirmed from tests of between subject effects on achievement. A

significant difference in effectiveness of the teaching methods was indicated (1,124)=27.74, p≤.001 in favour of simulation game.

However, consistent with the findings of Agbi (2006), this study reveals that teaching methods have statistically significant effectS on the achievement of students in chemistry. Also, Abe (2003), Akinsola (2007), Obeka (2002), and Longjohn (2009) declared significant effectiveness of the simulation game teaching method on achievement. Nevertheless, the findings of this study contradict that of Umo (2001) who declared no significant effect of simulation play strategy on students' achievement. Akintola (2007) also reported positive results from the use of the simulation-play method. The submission, therefore, is that the positive results obtained from the use of the simulation-play method resulted from the fact that the play requires the active participation of the students. In addition, the material being learned has a greater chance of being integrated into the cognitive structure of the students.

The Influence of Gender on Students' Interest in Organic Chemistry.

The study revealed that gender is a significant factor on students' overall interest in organic chemistry as shown in OCSII scores. On inspection, the male students' interest is significantly different from the females. This result agrees with the report of Isah (2005), Mari (2002), and, Okwo and Otuba (2007) that there is a prevalent significant effect of gender on the interest of students in the sciences in favour of the males. The finding is at variance with the reports of

Nworgu (2005) and Igboegwu (2005). They attributed any difference in mean to sampling error or method error and not due to gender. Nevertheless, differences could be attributed to factors which include the teaching strategies adopted (Nworgu, 2005); and economic, social, political and religious beliefs (Isa, 2005). The current researcher attributes any significant difference in means to gender and not sampling error or method.

The Influence of Gender on Students' Achievement in Organic Chemistry.

This study reveals a non-significant gender related difference in the students' achievement in chemistry. The male students and their female counterparts achieve without a significant difference as revealed by their mean scores in the learning of organic chemistry.

Gender is one of the factors suspected to interact with achievement, and studies on it have remained unresolved as findings of some researches show contradicting evidences in academic achievement of students due to gender. While some researchers found that male students achieve better than the females (Ukwungwu,2002; Mari,2002; Isa,2005; Okwo and Otubah,2007), others opined that the reverse is the case (Ekwueme and Impinyang,2006), while yet another group found no significant difference in the achievement of males and females, Aiyedum (2000), Damole and Abioye (2004). Umo (2001),Ifeakor (2005), Igboegwu (2010), and Ezeudu (1995) earlier remarked that this inconsistency causes a lot of concern for educationists. However, this study is consistent with

the last group as no gender difference in achievement was detected. Any difference in mean may be due to sampling error or method and not due to gender. Further, Nworgu(2005) explains this discrepant trend in gender-related differences in science achievements in terms of the interaction between gender and science content area. This means that depending on the nature and type of science content area in question, boys could either excel girls, or girls could excel boys or no difference may appear. According to Igboegwu (2010), another possible explanation of this phenomenon could be seen in terms of the interaction between gender and age. According to Wattanawaha and Clements (1992:878) in Igboegwu (2010), it is beyond dispute that in most cultures, sex-related difference in favour of males appear from adolescence. However, in my opinion, one should not forget that these students were studied in their co-educational schools. Having stayed together for more than five years, they may have developed similar or related learning patterns.

Conclusion

The study shows that teaching methods have significant effects on students' achievement and interest in organic chemistry. Indeed, the result indicates that the two strategies were effective but simulation play was outstanding and more effective than the concept mapping in engendering the aforementioned criteria measure. The influence of gender on interest was significant, but on achievement, it was not. Therefore, the male students demonstrated higher

achievement and interest based on the mean scores of OCSAT and OCSII respectively. Further, the interaction effect of teaching method and gender on students' interest is significant in favour of the males. On the other hand, the combined effect of teaching method and gender on students' achievement is not significant.

Educational implication

The findings of the present study have obvious educational implications for students, teachers and curriculum developers, policy makers in education and government. The study generally reveals that teaching methods are useful relative to students' achievement and interest in organic chemistry. From the study, males are better than their female counterparts in achievement and interest by their mean score but on further analysis it was confirmed that there was a significant difference between the post OCSII mean scores of male and female students while it was the contrary for OCSAT. However, this serves as an indicator to the gender related differences in achievement and interest. Therefore, there is need to normalize learning environment for both sexes since any gender related difference could be attributed to the differential socialization of their life differential character modification measures in the classroom and environment, and gender stereotypes in curriculum and instruction.

The study also revealed that innovative teaching method such as advanced organizers improve students' achievement and interest by their post mean OCSAT and OCSII. The implication is that in order to enhance students' achievement and interest, such innovative teaching methods should be introduced into class work to alternate or supplement the usual lecture method. In the study on SP, the male students recorded higher mean difference in interest and achievement scores. On analysis, the difference was not significant on the students' over all achievement and interest scores. This seems to contradict the marginal better achievement of the male or female students. The implication therefore is that the males and the females require these innovative advanced organizer teaching methods. Other possible variables that could affect this learning trend like environment and motivation should be ensured similar and attractive for both boys and girls by the teachers and educational administrators.

Developing the interest of students in a particular field of study makes for future upward trends in achievement. In this era of globalization and diversification of the resources of various nations, in-depth understanding of organic chemistry and science concept in general remains a very important matter of consideration. As various desirable traits, values, attitudes and habits the students need for the rest of their lives are developed in the school, teachers should use some of these identified teaching methods that have been found

effective in the classroom. This will enhance their intellects and development of extra -social competence.

The findings of the study with respect to the combined effect of teaching methods and gender on students' overall achievement in organic chemistry are not significant while it is significant on the interest of the students. Hence, both the males and females benefit equally from the teaching methods in terms of their achievements while some differences are found in the area of interest in favour of the males. However, it would imply that with appropriate teaching methods gender-related differences in chemistry achievement and interest could be reduced or even eliminated.

The ministry of education in Nigeria should organize seminars\workshops\conferences for chemistry teachers on the use of advanced organizers in teaching organic chemistry. As the study also reveals slight gender differences in achievement and interest of students in organic chemistry, the use of advanced organizers like SP and CM in teaching should be adopted for the purpose of promoting gender equality in the chemistry classroom.

Recommendations

The following recommendations were made based on the findings of the study.

1. Since the use of simulation play in teaching has been found more effective on the achievement and interest of students in organic chemistry, chemistry teachers should be encouraged to employ it in the teaching of the subject.

By so doing, the achievement and interest of students in organic chemistry could be improved.

2. The fact that higher mean achievement and interest scores were recorded through the use of SP and CM calls for teachers to acquaint themselves through training with the distinctive characteristics of the teaching techniques involving SP and CM with a view to enhancing students' achievement and interest for effective learning outcomes. This could be done through seminars, conferences and workshops organized by the Science Teachers' Association of Nigeria (STAN), Chemical Society of Nigeria (CSN) and the Curriculum Organization of Nigeria (CON).

3. Teacher training tertiary institutions should incorporate performance based instructional and playwriting techniques which can be learned from the simple to complex or from the known to unknown. This can be presented to the learner of the subject matter or the trainee teachers as the principles of preparing and assisting the learners to prepare quality simulation play. By so doing the students will learn willfully and better too.

4. The government and other educational authorities should organize seminars and workshops on regular basis to educate the in-service teachers on these innovative instructional strategies.

Limitations to the study

The generalizations drawn from this study are subject to the following limitations:

1. The number of co-educational schools selected was due to the nature of the research which involves one-on-one attention to the students and classroom instructions.
2. Though the research assistants were trained, their personalities and relationships with their students could influence the interest of the students.
3. Rigid time tabling and school locations made it impossible to randomly assign students to experimental groups; therefore, intact classes were used for the study.

Suggestions for further research

The finding of this study had generated some areas for further research such as:

1. Replicating the study using another educational zone of the state.
2. Determining the interaction effect of school location and teaching methods (SP and CM) on students' achievement and interest in organic chemistry.
3. Studying the effect of SP and CM on the achievement and interest of students in other areas like physical chemistry.

Summary

Poor achievement and interest of students in chemistry and science subjects in general remain recurring in literature. Organic chemistry is worse hit. Are the structure of the compounds and the organic nomenclature possible reasons? Or, could this be attributable to the use of ineffective and/or inappropriate teaching strategy? Also gender has been identified to affect both achievement and interest. The need to improve the teaching and learning of organic chemistry towards high achievement and interest development become a major issue for consideration. Consequently, this study sought to explore the comparative effectiveness of simulation play and concept mapping on the achievement and interest of students in organic chemistry. To guide this study, four research questions and six hypotheses were formulated. A Quasi-experimental non-randomized equivalent experimental group design was used. The study covered all the seven hundred and one senior secondary three students in the 40 government-owned secondary schools in the Ogidi Education Zone of Anambra State as the population of the study. The sample consists of all the 129 chemistry students in the four selected co-educational schools in the zone. The students in their intact classes were assigned to the two experimental groups (simulation play group and concept mapping group). They were separately taught by research assistants who were trained for the purpose. Identified extraneous variables, which could pose potential threat to the validity of the study were controlled. All the groups were pre- and post-tested.

The main instruments for data collection were:

Organic Chemistry Students achievement test (OCSAT)

Organic Chemistry Students interest inventory (OCSII)

The OCSAT was developed by the researcher following the test blue print on SSCE exanimations to ensure content validity while the OCSII was adapted from a developed vocational interest inventory. The OCSAT was validated by the researcher's supervisor, chemistry teachers and measurement and evaluation experts. The OCSAT was trial tested and the data collected gave a reliability estimate of 0.78 using Pearson product moment while an internal consistency of 0.82 using Kuder Richerdson Fumular 20 was computed for the OCSII. The data generated from the study were analyzed using mean and standard deviation (SD). Analysis of covariance (ANCOVA) was used to test all the hypotheses at 0.05 level of significance. The result from the data analyzed shows that:

- The use of SP and CM were significant factors in the students overall achievement and interest.
- Gender is not a significant factor in the students overall achievement in organic chemistry.
- No significant interaction between teaching method and gender was detected in the students' overall achievement in organic chemistry.
- Gender has significant effect on students' interest as the males showed more interest than the female students in organic chemistry.
- Interaction due to teaching method and gender on student interest is significant

Following the discussion of the findings and the educational implications, it was recommended that both trainee teachers and those in the field should be trained on the skills of simulation game. Also seminars, workshops and conferences should be organized by educators, the ministry of education and STAN to acquaint and re-orient teachers on the skills for SG constructions. The limitations of the study were highlighted, and suggestions for further areas of research made. Based on the findings of the study, it was concluded that SP as a more effective teaching method should be employed in the teaching of chemistry, especially, organic chemistry, as a means of improving academic achievement and interest of students.

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APPENDIX A

LIST OF SCHOOLS IN OGIDI EDUCATION ZONE ACCORDING TO L.G.As & SCHOOL TYPES

S/No	L.G.A	Name of schools	School type
1.	Idemili North	NDSS Abatete	Co- Education
2.		ASS Abatete	Co-Education
3.		CSS Eziowelle	Co-Education
4.		CSS Ideani	Co-Education
5.		GTC Nkpor	Co-Education
6.		USS Nkpor	Co-Education
7.		CSS Obosi	Co-Education
8.		USS Obosi	Co-Education
9.		BSS Ogidi	Boys
10.		AGSS Ogidi	Girls
11.		CSS Oraukwu	Co-Education
12.		OGS Oraukwu	Boys
13.		CSS Uke	Co-Education
14.		MASS Umuoji	Girls
15.		CSS Umuoji	Co-Education
16.		Awada SS Obosi	Co-Education
17.	Idemili South	SJSS Akwu-Ukwu	Co-Education
18		SJS & TECH college, Alor	Boys
19.		C S S. Alor	Girls
20.		GSS Awka-Etiti	Girls
21.		SJSS Awka-Etiti	Boys
22.		OLSS Nnobi	Co-Education
23.		CSS Nnobi	Co-Education

24.		CSS Nnokwa	Co-Education
25.		USS Nnokwa	Co-Education
26.		GSS Oba	Girls
27.		MOLS Oba	Boys
28.		BSS Ojoto	Boys
29.		GSS Ojoto	Girls
30.	Oyi	CSS Awkuzu	Co-Education
31.		USS Awkuzu	Co-Education
32.		WEC Awkuzu	Girls
33.		MCSS Nkwelle Ezunaka	Co-Education
34.		CHS Nkwelle Ezunaka	Co-Education
35.		NESS Nteje	Co-Education
36.		BHS Nteje	Boys
37.		CCSS Ogbunike	Co-Education
38.		SMC Ogbunike	Girls
39.		CSS Umunya	Co-Education
40.		PSS Umunya	Co-Education

APPENDIX B

ORGANIC CHEMISTRY STUDENTS' INTEREST INVENTORY (OCSII)

(The final copy, ie after adjustments)

Below is a list items made to investigate the degree of students interest in chemistry. You are requested to rate yourself to indicate the degree to which items are representative of you. Be as sincere as possible in your rating. This is examination and has nothing to do with your result. All information you will provide will be regarded as highly confidential and will be treated as such.

(Researcher)

School:_____

Sex: Male[ ] Female[ ] Age[ ]

Note: SA means Strongly Agree
A means agree
UN means Undecided
D means Disagree
SD means Strongly Disagree

S/NO.	ITEMS	SA	A	UN	D	DA
1.	I like being taught chemistry very often.					
2.	I will like to pursue a chemistry related course after my secondary school education.					
3.	I do not like participating in chemistry practical.					
4.	I like having my chemistry lessons in the laboratory.					
5.	I like putting on my laboratory coat during practical lessons.					
6.	I like solving chemical problems by carrying					

	out experiments.					
7.	I like to know the names of the apparatus in the chemistry laboratory.					
8.	As a chemist. I sometimes have the urge to visit petrochemical industries.					
9.	I like to spend my free time on films based on chemical issues.					
10.	I like going near the chemistry laboratory everyday.					
11.	I will like to work in a chemical research institute after my schooling.					
12.	To work as a chemist will be boring					
13.	I will like to determine the amount of Nicotine in a bottle of Coca-cola.					
14.	I will like to use hard water in laundry.					
15.	I like to discuss the usefulness of chemistry during this year's career day of my school.					
16.	I dislike to participate in workshops organized on chemical issues					
17.	During the holidays, I will like to teach chemistry in Adult Education Programme if invited.					
18.	I like using chemical terms when discussing with my mates.					
19.	I will like to have a Periodic Table in my house.					
20.	I enjoy solving past chemistry examination questions on my own.					

21.	I usually complete my chemistry assignments on time.					
22.	I volunteer to call our chemistry teacher whenever it is time for the subject.					
23.	I rejoice whenever our chemistry teacher is absent from class.					
24.	I keep myself busy with coping notes of other subjects during chemistry lessons.					
25.	I enjoy reading chemistry at least 45 minutes every day.					
26.	I advise my friends against choosing chemistry as a subject for external examination.					
27.	In a group for practical work, I like recording results rather than participating to understand.					
28.	Chemistry is difficult to understand.					
29.	Chemistry does not contribute much to our existence.					
30.	Man’s problems are solved by chemistry.					

APPENDIX C

ORGANIC CHEMISTRY STUDENTS' INTEREST INVENTORY (OCSII)

(The original copy, ie before the adjustments)

Below is a list items made to investigate the students' interest in chemistry. You are requested to rate yourself to indicate the degree to which items are representative of you. Be as sincere as possible in your rating. All information you will provide will be regarded as highly confidential and will be treated as such.

(Researcher)

School:_____

Sex: Male[ ] Female[ ] Age[ ]

Note: LVM means Like very much
L means Like
D means Dislike
DVM means Dislike very much

S/NO.	ITEMS	LVM	L	D	DVM	
1.	I like being taught chemistry very often.					
2.	I will like to pursue a chemistry related course after my secondary school education.					
3.	I do not like participating in chemistry practical.					
4.	I like having my chemistry lessons in the laboratory.					
5.	I like putting on my laboratory coat during practical lessons.					
6.	I like solving chemical problems by carrying out experiments.					
7.	I like to know the names of the apparatus in the chemistry laboratory.					
8.	As a chemist. I sometimes have the urge to visit petrochemical industries.					
9.	I like to spend my free time films based on chemical issues.					

10.	I like going near the chemistry laboratory everyday.					
11.	I will like to work in a chemical research institute after my schooling.					
12.	To work as a chemist will be boring					
13.	I will like to determine the amount of nicotine in a bottle of Coca-cola.					
14.	I will like to use hard water in laundry.					
15.	I like to discuss the usefulness of chemistry during this year's career day of my school.					
16.	I dislike to participate in workshops organized on chemical issues					
17.	During the holiday. I will like to teach chemistry in Adult Education Programme if invited.					
18.	I like using chemical terms when discussing with my mates.					
19.	I will like to have a Periodic Table in my house.					
20.	I enjoy solving past chemistry examination questions on my own.					
21.	I usually complete my chemistry assignments on time.					
22.	I volunteer to call our chemistry teacher whenever it is time for the subject.					
23.	I rejoice whenever our chemistry teacher is absent from class.					
24.	I keep myself busy with coping notes of other subjects during chemistry lessons.					
25.	I enjoy reading chemistry at least 45 minutes every day.					
26.	I advise my friends against choosing chemistry as a subject for external examination.					
27.	In a group for practical work, I like recording results rather than participating to understand.					

28.	Chemistry is difficult to understand.					
29.	Chemistry does not contribute much to our existence.					
30.	Man's problems are solved by chemistry.					

(Ifeakor, 2005)

APPENDIX D

ORGANIC CHEMISTRY STUDENTS' ACHIEVEMENT TEST (OCSAT)

(The final copy)

School……..

Female [ ] Male [ ] Age [ ]

Instruction: Answer all the questions; circle A, B, C or D that bears the correct answer to each item below: Erase clearly any answer you wish to change.

Time Allowed: 1 hour

1. Which of these is an acid?
   (A) HCOOH (B) C_2H_5OH (C) $HCOOC_2H_5$ (D) H_2CO
2. Esters are used in the following except
   (a) Making perfumes (b) Making Cement (c) As Solvent for cellulose nitrate (d) As Nail varnishes.
3. An alkanoic acid reacts reversibly with an alkanol to produce
   (a) Soap (b) An amide (c) An Ester (d) A Sugar
4. One of these is an example of condensation reaction.
   (a) Reduction reaction (b) Addition reaction (c) Esterification reaction
   (d) Substitution reaction.
5. Combination of organic acid with alcohol to form ester and water is known as (a) Polymerization (b) Saponification (c) Esterification (d) Alkylation.
6. All of these are physical properties of ester, except one
   (a) It is a colourless liquid
   (b) It is slightly soluble in water
   (c) It has a boiling point of about 77.1^{o}C

(d) It is a brownish gas.

7. Ester can be hydrolysed by water to form

(a) Acid and oil (b) Acid and Paint (c) Acid and alkanol

(d) Alkanol and water.

8. The process of hydrolyzing fats and oil with caustic alkali to yield propan- 1, 2, 3-triol and soap is known as

(a) Condensation (b) Saponification (c) Esterification (d) Polymerisation.

9. The reaction of fats and oil with potassium hydroxide (KOH) gives

(a) Soft soap (b) Omo (c) Hard soap (c) Detergent

10. Which of these is an alcohol

(a) C_2H_5OH (b) HCOOH (c) $HCOOC_2H_5$ (d) H_2CO

11. One of the following is an example of ester

(a) ethylethanoate (b) ethanoic acid (c) potassium hydroxide (d) ethanol

12. Given the equation, $C_2H_5OH + CH_3COOH\text{-}CH_3COOC_2H_5 + H_20$ the major product is

(a) C_2H_5OH (b) $+CH_3COOH$ (c) $CH_3COOC_2H_5$ (d) H_2O

13. The reversibility of esterification reaction connotes that

(a) It can be hydrolyzed by water to give the reactants

(b) It can be hydrogenated to give hydro ester

(c) It can undergo substitution reaction

(d) It can undergo addition reaction

14. The chemical breakdown of compound due to reaction with water is called

(a)Effervescence (b) Precipitation (c) Hydrogenation (d) Hydrolysis.

15. Liquid soap used for bathing is an example of

(a) Hard soap (b) Soft soap (c) Caustic Soda (d) Detergent

16. Saponification is useful in fire extinguishing because soap is

(a) flammable (b) hydroscopic (c) efflorescent (d) luster

17. What type of reaction occurs between vegetable oil and caustic alkali?

(a)Displacement (b)Dehydration(c) Neutralization (d) Saponification

18. Choose the correct option

(a) Fats and oils are insoluble in water

(b) Fats and oils are strongly soluble in water

(c) Fats and oil are soluble in water

(d) Fats and oil are insoluble in ether.

19. Fats and oils belong to the group of compounds known as

(a) Alkanols(b) Lipids (c) Alkanes (d) Amino acids

20. Consider the reaction below:

Fat and oil +P $\longrightarrow$ Soap + propane, 1,2,3-triol, p-represents

(a) Soda water (b) Soda alkali (c) Caustic alkali (d) Chloroform

21. The end product of alkaline hydrolysis of fats and oils is

(a) soap (b) lime (c) water (d) mineral

22. Another name for propane, 1,2,3-triol is

(a) trycerol (b) glycerol (c) propynol (d) propanone

23. Consider the reaction below:

$$\begin{array}{l} R^{I}COOCH_2 \\ R^{II}COOCH \\ R^{III}COOCH_2 \end{array} + 3NaOH \longrightarrow \begin{array}{l} R^{1}COO^{-}Na^{+} \\ R^{II}COO^{-}Na^{+} \\ R^{III}COO^{-}Na^{+} \end{array} + \begin{array}{l} HO\text{-}CH_2 \\ HO\text{-}CH \\ HO\text{-}CH_2 \end{array}$$

(A) (B) (C) (D)

(B) The compound denoted with A is (a) Facts and oils/lipids

(b) Glycerol/Propane1,2,3-triol (c) Soap/detergent (d) Caustic soda/caustic potash

24. Soap can be used (a) in textile spinning (b) as moisturing agent (c) as plasticizers (d) as an emulsifier

25. Saponification occurs in the presence of a catalyst
(a) true (b) false

26. The reaction between alkanol and alkanoic acid in the presence of a mineral acid is known as:
(a) displacement (b) Neutalization (c)saponification (d) Esterification

27. What is the major product formed when C_2H_5OH reacts with CH_3OOH ?
(a)$C_2HCOOC_2H_3$ (b) $C_2H_5COCH_3$ (c) $CH_3COOC_2H_5$ (d) C_2H_5COOH

28. Esterification of propan 1,2,3-triol and unsaturated higher carboxylic acid will produce
(a) Fats (b) Soap (c) Methyl-propanoate (d) Oils

29. The following are miscible with water except
(a) ethylethanoate (b) methanol (c) ethanoic acid (d) ethanol

30. The reverse of the following reaction is called;
Alkonol + Alkanoic acid---Conc-H_2SO_4--- Alkanoate + Water
(a)neutralization (b)dehydration (c)hydrolysis (d)decomposition

31. In the following reaction the mineral acid as :
$HCOOH + CH_3CH_2OH$ ----H+----- $HCOOC_2H_5 + H_2O$.
(a)Catalyst (b)reducing agent (c) oxidizing agent (d)water

32. Which of the following statements is not correct about esterification.
(a) it is a slow reaction (b) The process is reversible
(c)it is the same as hydrolysis (d) It is catalysed by acids

33. In the reaction, $CH_3COOC_2H_5(aq) + 4(H)$----$LiALH_4$---- $2C_2H_5OH(aq)$
The Lithiumtetrahydridoaluminate(III)LiALH4 Serves as:
(a) Oxidizing agent (b)Reducing agent (c)Catalyst (d)Propellant

34. The reaction between an ester and water is called
(a)Saponification (b)Hydrolysis (c) Polymerization(d) Dehydration

35. A colourless volatile liquid with pleasant smell and boils at $75^{O}C$ could be suspected to be (a)margarine (b) Ethanoic acid (c)methanol(d)ethylethanoate

36. The following compounds are esters except:
(a)$C_2H_5COOCH_3$(b)$CH_3CH_2COOCH_2CH_3$(c)C_2H_5COOH(d)CH_3COOCH_3

37. The formation of ethylethanoate involves the reaction between ethanol and (a)methanoic acid(b)propanoic acid (c)Butanoic acid (d)ethanoic acid

38 The major difference between esterification saponifiction reactions is that while esterification yields_____,saponification yields_____.

(a)Ester,Fat (b) oil, soap (c) ester, soap. (d) soap, ester.

39. The end product of saponification is (a)soap (b) ester (c)Lye (d)fats and oils

40. The two types of soap are;
(a) Hard and Soft(b)Hot and dull (c)pasty and gell-like (d)Omo and Detergent.

APPENDIX E

Model answers to the OCSAT, after validation.

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

APPENDIX F

ORGANIC CHEMISTRY STUDENTS' ACHIEVEMENT TEST (OCSAT) BEFORE VALIDATION

School……..

Female [ ] Male [ ] Age [ ]

Instruction: Answer all the questions; circle A, B, C or D that bears the correct answer to each item below: Erase clearly any answer you wish to change.

Time Allowed: 1 hour

1. Which of these is an acid?

   (A) HCOOH (B) C_2H_5OH (C) $HCOOC_2H_5$ (D) H_2CO

2. Esters are used in the following except

   (a) Making perfumes (b) Making Cement (c) As Solvent for cellulose nitrate (d) As Nail varnishes.

3. An alkanoic acid reacts reversibly with an alkanol to produce

   (a) Soap (b) An amide (c) An Ester (d) A Sugar

4. One of these is an example of condensation reaction.

   (a) Reduction reaction (b) Addition reaction (c) Esterification reaction (d) Substitution reaction.

5. Combination of organic acid with alcohol to form ester and water is known as (a) Polymerization (b) Saponification (c) Esterification (d) Alkylation.

6. All of these are physical properties of ester, except one

   (a) It is a colourless liquid

   (b) It is slightly soluble in water

   (c) It has a boiling point of about 77.1^{o}C

   (d) It is a brownish gas.

7. Ester can be hydrolysed by water to form

(a) Acid and oil (b) Acid and Paint (c) Acid and alkanol

(d) Alkanol and water.

8. The process of hydrolyzing fats and oil with caustic alkali to yield propan- 1, 2, 3-triol and soap is known as

(a) Condensation (b) Saponification (c) Esterification (d) Polymerisation.

9. The reaction of fats and oil with potassium hydroxide (KOH) gives

(a) Soft soap (b) Omo (c) Hard soap (c) Detergent

10. These are uses of soap except.

(a) washing (b) cooking (c) cleaning (d)bathing

11. Which of these is an alcohol

(a) C_2H_5OH (b) HCOOH (c) $HCOOC_2H_5$ (d) H_2CO

12. One of the following is an example of ester

(a) ethylethanoate (b) ethanoic acid (c) potassium hydroxide (d) ethanol

13. Given the equation, $C_2H_5OH + CH_3COOH\text{-}CH_3COOC_2H_5 + H_20$ the major product is

(a) C_2H_5OH (b) $+CH_3COOH$ (c) $CH_3COOC_2H_5$ (d) H_2O

14. The reversibility of esterification reaction connotes that

(a) It can be hydrolyzed by water to give the reactants

(b) It can be hydrogenated to give hydro ester

(c) It can undergo substitution reaction

(d) It can undergo addition reaction

15. Which of these is the formular for ethanoic acid

(a) $CH_3\ COOC_2\ H_5$ (b)CH_3COOH (d)NaOH (d)H_2SO_4

16. $C_2H_5OH+CH_3COOH$ hydrolysis $CH_3COOC_2H5+H_20$

The reaction is called

(a) Reduction Reaction (b) Saponification reaction

(c) Addition reaction (d) esterification reaction

17. The chemical breakdown of compound due to reaction with water is called

(a)Effervescence (b) Precipitation (c) Hydrogenation (d) Hydrolysis.

18. Liquid soap used for bathing is an example of

(a) Hard soap (b) Soft soap (c) Caustic Soda (d) Detergent

19. Saponification is useful in fire extinguishing because soap is

(a) flammable (b) hydroscopic (c) efflorescent (d) luster

20. What type of reaction occurs between vegetable oil and caustic alkali?

(a)Displacement (b)Dehydration(c) Neutralization (d) Saponification

21. Choose the correct option

(a) Fats and oils are insoluble in water

(b) Fats and oils are strongly soluble in water

(c) Fats and oil are soluble in water

(d) Fats and oil are insoluble in ether.

22. Fats and oils belong to the group of compounds known as

(a) Alkanols(b) Lipids (c) Alkanes (d) Amino acids

23. The compound that can otherwise be called lye is

(a) KOH (b) $RCOO^{-}K^{1}$ (c) $HO\text{-}CH_2$ ()d RCOOCH (e) $HO\text{-}CH_2$

24. The IUPAC name for HO - CH_2 is

HO - ^{1}CH-

HO - $1CH_2$

a. Propan-1,2,3-trio (b) lye (c) Serbitol (d)Mannitol

25. Consider the reaction below:

Fat and oil +P $\longrightarrow$ Soap + propane, 1,2,3-triol, p-represents

(c) Soda water (b) Soda alkali (c) Caustic alkali (d) Chloroform

26. The end product of alkaline hydrolysis of fats and oils is

(a) soap (b) lime (c) water (d) minerial

27. Another name for propane, 1,2,3-triol is

(a) trycerol (b) glycerol (c) propynol (d) propanone

28. Consider the reaction below:

$$\begin{array}{l} R^{I}COOCH_2 \\ R^{II}COOCH \\ R^{III}COOCH_2 \end{array} + 3NaOH \longrightarrow \begin{array}{l} R^{1}COO^{-}Na^{+} \\ R^{II}COO^{-}Na^{+} \\ R^{III}COO^{-}Na^{+} \end{array} + \begin{array}{l} HO\text{-}CH_2 \\ HO\text{-}CH \\ HO\text{-}CH_2 \end{array}$$

(C) (B) (C) (D)

(D)The compound denoted with A is (a) Facts and oils/lipids (d)Glycerol/Propane1,2,3-triol (c) Soap/detergent (d) Caustic soda/caustic potash

29. Soap can be used (a) in textile spinning (b) as moisturing agent (c) as plasticizers (d) as an emulsifier

30. Saponification occurs in the presence of a catalyst

(a) true (b) false

31. The reaction between alkanol and alkanoic acid in the presence of amineral acid is known as:

(a) displacement (b) Neutalization (c)saponification (d) Esterification

32. Fats are classified as (a) Hydrocarbons (b) Alkanoates (c) Alkonols (d) carbohydrates.

33. The hardening of oils is knowns as (a) Saponification (b)hydrogenation (c) Hydration (d) Esterification

34. What is the major product formed when C_2H_5OH reacts with CH_3OOH ?

(a)$C_2HCOOC_2H_3$ (b) $C_2H_5COCH_3$ (c) $CH_3COOC_2H_5$ (d) C_2H_5COOH

35. Esterification of propan 1,2,3-triol and unsaturated higher carboxylic acid will produce

(a) Fats (b) Soap (c) Methyl-propanoate (d) Oils

36. The following are miscible with water except

(a) ethylethanoate (b) methanol (c) ethanoic acid (d) ethanol

37. The reverse of the following reaction is called;

Alkonol + Alkanoic acid---Conc-H_2SO_4--- Alkanoate + Water

(a)neutralization (b)dehydration (c)hydrolysis (d)decomposition

38. In the following reaction the mineral acid as :

$HCOOH + CH_3CH_2OH$ ----H+----- $HCOOC_2H_5 + H_2O$.

(b) Catalyst (b)reducing agent (c) oxidizing agent (d)water

39. Which of the following statements is not correct about esterification.

(a) it is a slow reaction (b) The process is reversible

(c)it is the same as hydrolysis (d) It is catalysed by acids

40. In the reaction, $CH_3COOC_2H_5$(aq) +4(H)----$LiALH_4$---- $2C_2H_5OH$(aq)

The Lithiumtetrahydridoaluminate(III)LiALH4ves as:

(a) Oxidizing agent (b)Reducing agent (c)Catalyst (d)Propellant

41. Consider the reaction below

- Fat and oil + P – Soap + propane , 1,2,3 –triol, p-represents

(a) soda water- (b) soda alkali (c) caustic alkali (d) chloroform

42. One of the following is not a lipid (a) lard (b) butter (c) olive oil (d) gas oil

43. Fats and oils are used as essential ingredients for (a) phenols (b) drinks (c) foods (d) ketones

44. Fats are soluble in the following except = (a) Chlorine (b) carbontetrachloride (c) chloroform (d) carbondisulphide

45. The hydrogenation of oils produces (a) liquid fats (b)solid fats (c)solid oils (d) esters.

46. The reaction between an ester and water is called

(a)Saponification (b)Hydrolysis (c) Polymerization(d) Dehydration

47. A colourless volatile liquid with pleasant smell and boils at $75^{O}C$ could be suspected to be (a)margarine (b) Ethanoic acid (c)methanol(d)ethylethanoate

48. The following compounds are esters except:
(a)$C_2H_5COOCH_3$(b)$CH_3CH_2COOCH_2CH_3$(c)C_2H_5COOH(d)CH_3COOCH_3

49. Which of the following substances is a suitable solvent for perfumes?
(a) Ethylethanote (b)turpentine (c)menthol (d) water

50. The formation of ethylethanoate involves the reaction between ethanol and …… acid.
(a)methanoic (b)propanoic (c)Butanoic (d)ethanoic

51 Which of the following substances could be responsible for the banana taste of a food flavour.
(a)Methylbenzone (b)Butanol (c) Ethanol (d) Pentylethanoate

52 The major difference between esterification and saponifiction reactions is that while esterification yields_____,saponification yields_____.

(b)Ester,Fat (b) oil, soap (c) ester, soap. (d) soap, ester.

53. The end product of saponification is (a)soap (b) ester (c)Lye (d)fats and oils

54. Which of the following compound is an alkanol

(a) CH_3CH_2COOH(b)CH_3 CH_2 OCH_3 (c) $CH_3COOC_2H_5$ (d) CH_3 CH_2 OH

55. What is the IUPAC name of CH_3 $COOH_3$?

56. The two types of soap are (a) Hard and Soft (b) Hot and dull (c) pasty and gell-like (d) Omo and Detergent.

57. The products of esterification usually have a fruity smeel.

(a) Disagree (b) Not always true (c) strongly agree (d) strongly disagree

58. Which of the following is correct, Esters are (a) Strongly soluble in water (b) Soluble in water (c) Slightly soluble in water (d) Strongly insoluble in water.

59. Ammonia when bubbled through an ester can produce an (a) amide and alkanol (b) amine and alkanol (c) amine and ketone (d) amide and ketone

60. Identify the odd member in the following:

    (a) Alkanol (b) Alkanoic acide (c) water (d) Esters (e) Amine

APPENDIX G

MODEL ANSWERS TO OCSAT BEFORE VALIDATION

1. A
2. B
3. C
4. C
5. C
6. D
7. C
8. B
9. A
10. B
11. A
12. D
13. C
14. A
15. C
16. D
17. D
18. B
19. B
20. D
21. A
22. B
23. A
24. A
25. B
26. A
27. B
28. B
29. B
30. B
31. B
32. B
33. B
34. D
35. C
36. A
37. C
38. A
39. B
40. C
41. C
42. D
43. C
44. A
45. B
46. A
47. B
48. D
49. C
50. D
51. D
52. C
53. A
54. D
55. B
56. A
57. C
58. B
59. C
60. D

APPENDIX H

Distribution of SS 3 Chemistry students used for the study

Group	Instructional method	Gender		Total
		Male	Female	
E_1	Concept Mapping	30	39	69
E_2	Simulation game	31	29	60
Total		61	68	129

APPENDIX I

Scheme of work for the study

TOPIC	CONTENT
Lessons: Esterification –	Concept of esterification Preparation of esters Properties and Uses of esters.
Lessons: Saponification –	Concept of saponification Preparation of soaps Properties and Uses of soaps.

APPENDIX J

LESSON 1

CONCEPT MAPPING STRATEGY ON SAPONIFICATION, $E_{2.1}$

Class: SS3

Age: 15-17 yrs

Time: 2 periods of 40 mins each

Topic: Concept of Saponification

SPECIFIC OBJECTIVES:

By the end of this lesson, the students will be able to:

i. Explain the word saponification.

ii Explain fats and oils with examples.

ENTRY BEHAVIOUR:

The students can identify oils and can recognize samples of soap.

SET INDUCTION:

The teacher presents samples of soap and oil to the students and asks them to identify them. He reinforces and introduces the lesson.

INTRODUCTION:

The teacher explains the soaps are made from fats and oils, and hydroxides of sodium and potassium by a process called saponification.

STEP 1

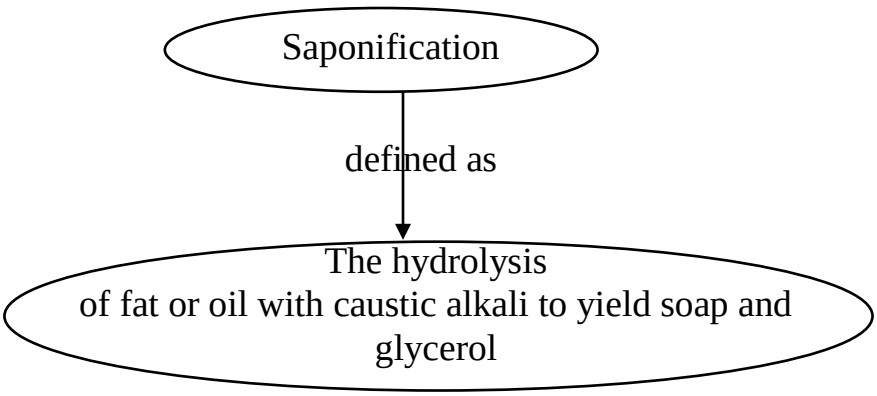
The teacher therefore defines saponification as the alkaline hydrolysis of fats and oils to yield propan,-1,2,3-triol and soap which is the corresponding sodium or potassium saits of the component fatty acid. This can be represented literally as follows:

Fat or Oil + Alkali -------- soap + propan 1,2,3- triol

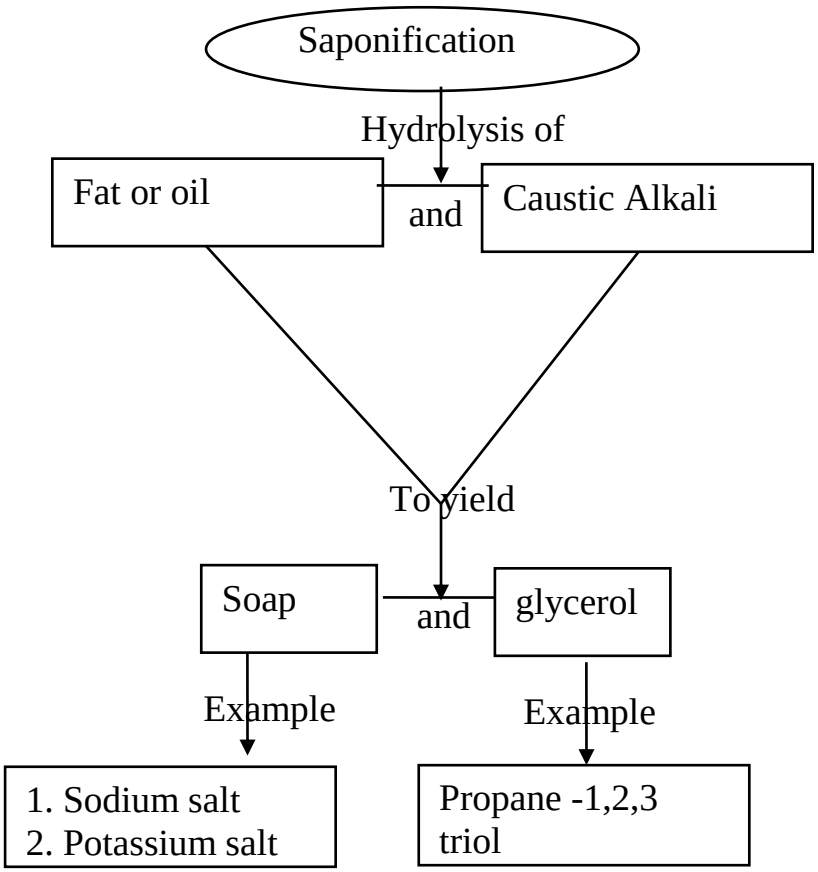
(sodium or potassium salt) (glycerol)

STEP 2

The teacher presents the concept map and briefs the students on the nature of concept map with regards to saponification. The tool is aimed at illustrating the meaning of saponification, its process and the production of soap. The tool will also illustrate the properties of soap and its uses.The teacher then draws a concept map of the concept of saponification as follows:



.He gives a more detailed concept map as follows:



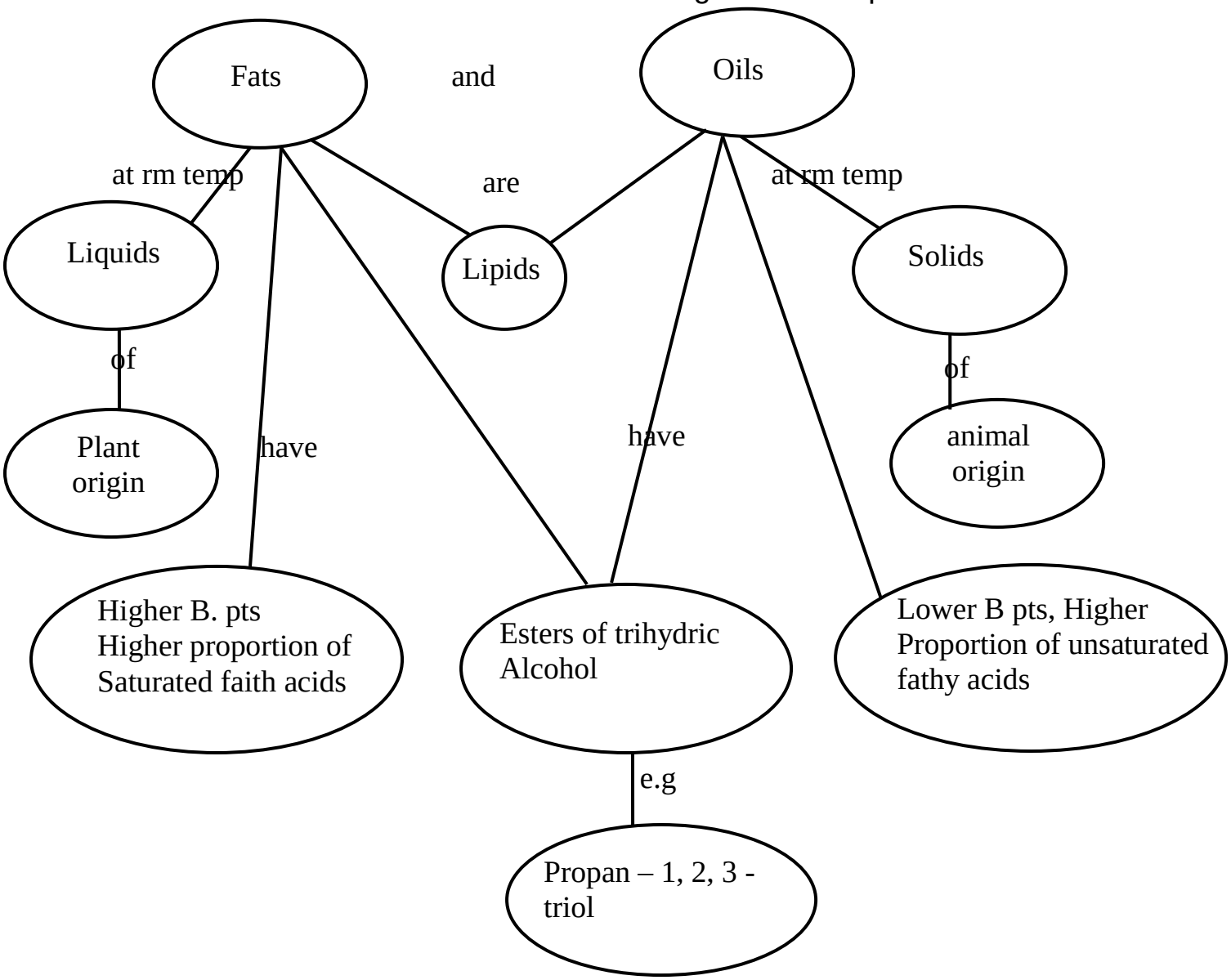
STUDENTS ACTIVITIES:

They pay attention to the teacher, construct their own maps and ask questions where necessary.

STEP 3

The teacher introduces the concepts of fats and oils, and defines them as esters of trihydric alkanols which belongs to a general group of compounds known as lipids. Fats are solids usually of animal origin while oils are liquids mainly from plants.

The teacher takes the students through the concept as follows:



The teacher goes round to inspect the maps drawn by the students. He corrects their mistakes and gives a general review of the lesson.

EVALUATION:

i. Explain the word saponification.

ii Explain fats and oils with examples.

CLOSSURE:

The teacher reinforces, asks them to present better map in the next class and adjourns for “process of saponification”.

LESSON 2

CONCEPT MAPPING STRATEGY ON SAPONIFICATION, $E_{2.1}$

Class: SS3

Age: 15-17 yrs

Time: 2 periods of 40 mins each

Topic: Process of Saponification according to their types.

SPECIFIC OBJECTIVES:

By the end of this lesson, the students will be able to:

i. Explain the process of saponification.

ii Mention the properties of soap (Chemical and physical) .

ENTRY BEHAVIOUR:

The students can define saponification and give examples of fats and oils.

SET INDUCTION:

The teacher asks them to define saponification and give examples of fats and oils. He reinforces and introduces the lesson.

INTRODUCTION:

The teacher recalls the concept of saponification and fats and oils, and introduce the process of saponification according to soap types.

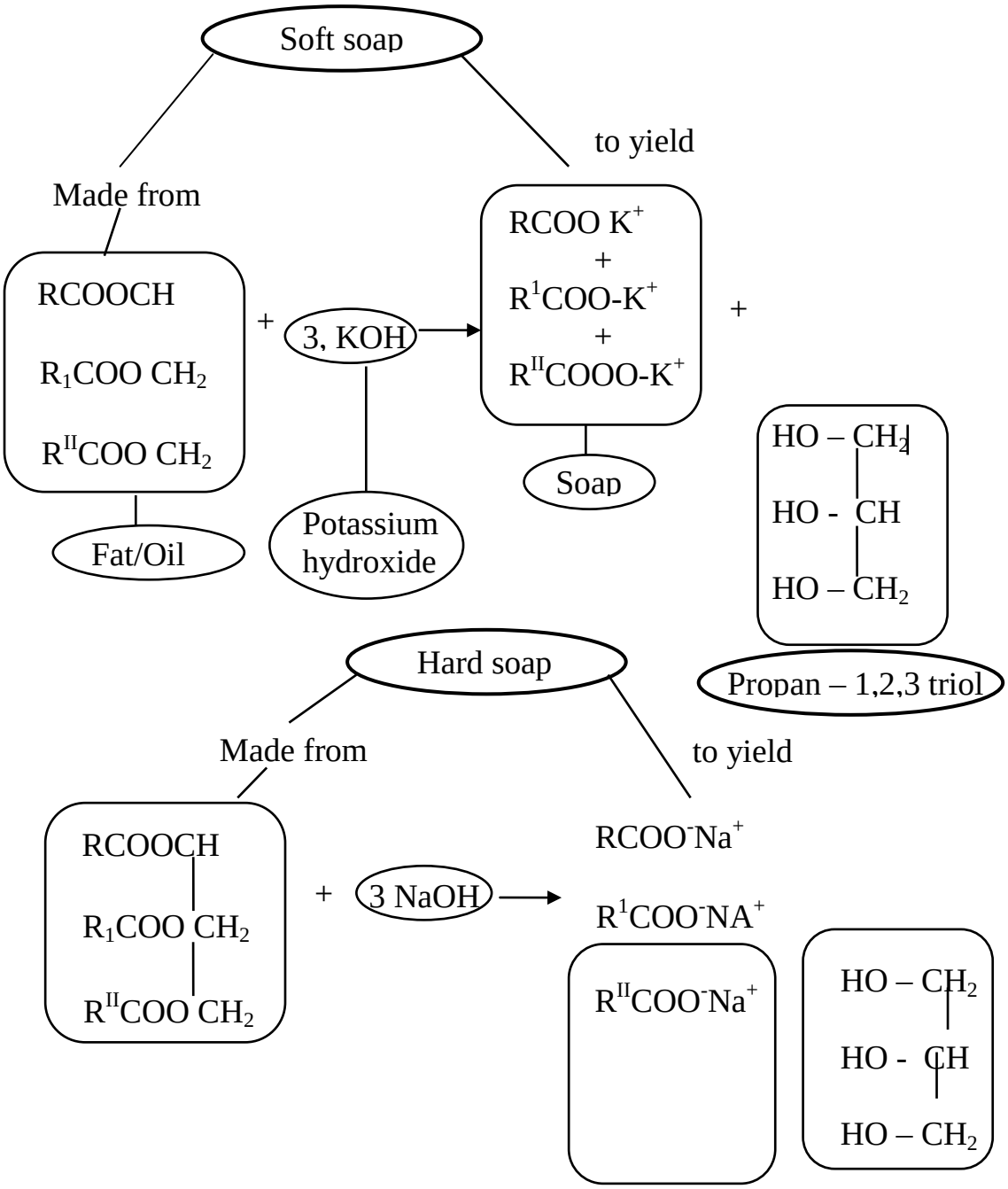
STEP 1

The teacher uses literal equations to explain the processes as follows:

i. Fats or oil + potassium hydroxide -------- soft soap + glycerol
ii. Fats or oil + sodium hydroxide -------- Hard soap + glycorol

STEP II

The teacher them informs the students that this process can be illustrated using concept maps. He then constructs the following map with the entire class participating. The teacher explains the equations for the preparations of hard soap and soft using concept maps as follows:



The teacher goes round to inspect the maps drawn by the students. He corrects their mistakes and gives a general review of the lesson.

EVALUATION:

i Explain the process of saponification.

ii Mention the differences between soft and hard soaps. .

CLOSURE:

The teacher reinforces, asks them to present better map in the next class and adjourns for “types and uses of soap”.

LESSON 3

CONCEPT MAPPING STRATEGY ON SAPONIFICATION,

Class: SS3

Age: 15-17 yrs

Time: 2 periods of 40 mins each

Topic: Types and uses of soap

SPECIFIC OBJECTIVES:

By the end of this lesson, the students will be able to:

i. Mention and explain the two types of Soap

ii. Give at least 3 uses of Soap

iii Explain the preparation of soap.

Entry Behaviour: Student can define and identify fats and oils, and caustic solutions.

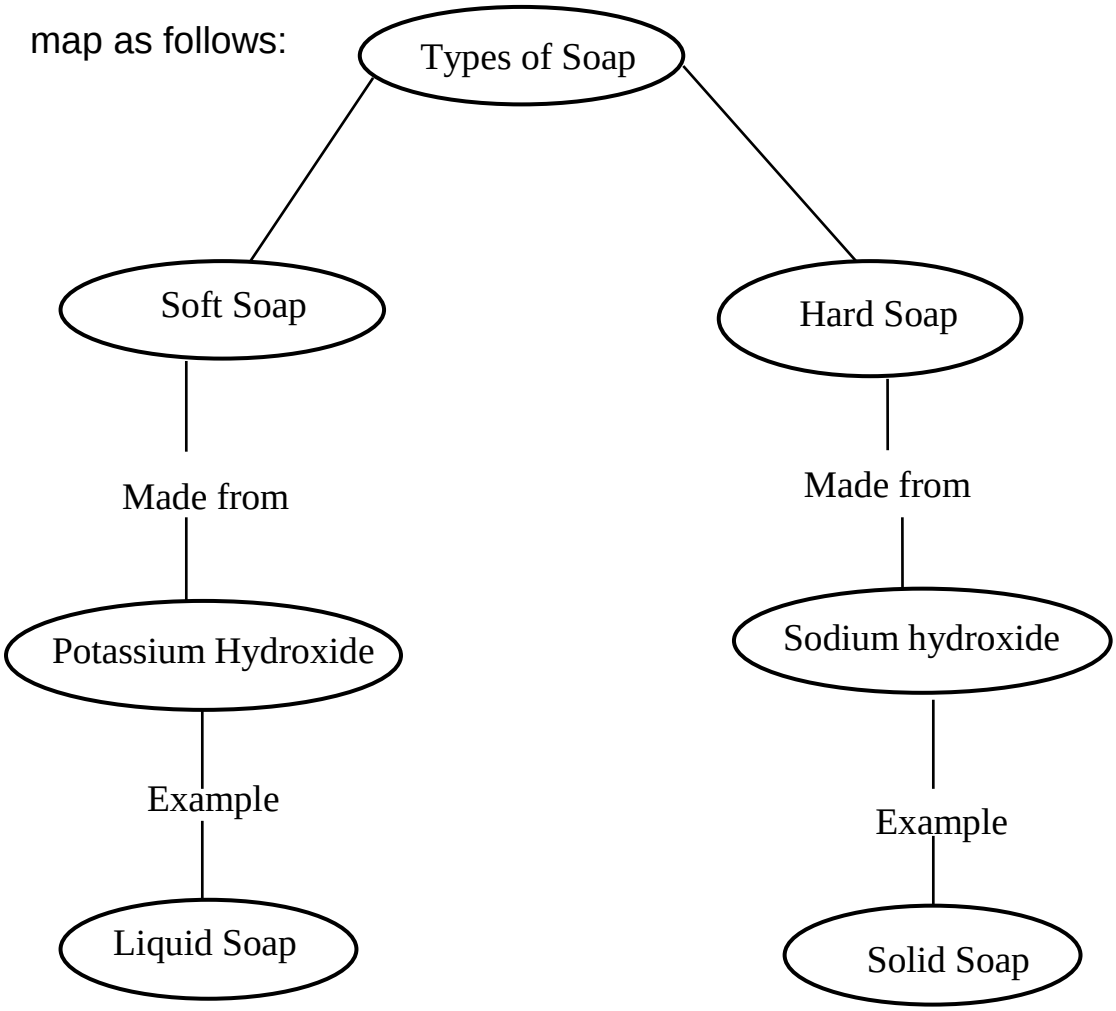
Set induction: Asks them to define fats and oils, and describe the caustic solutions. Reinforce.. At each step, the students are expected to draw with the teacher as he draws and leads them.

Introduction:

The teacher recalls the concept to saponification and introduces the lesson, Types and uses of soap

STEP I

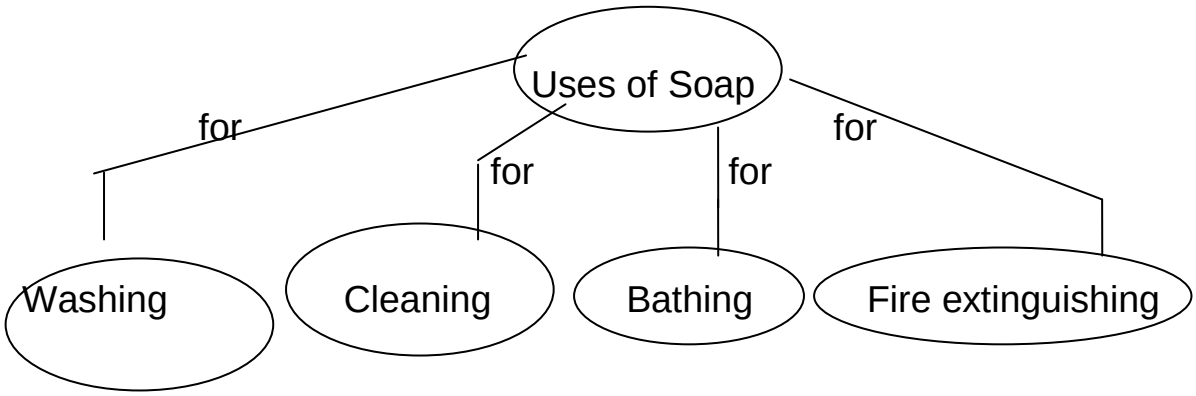
The teacher explains the types of soap to the students using concept map as follows:



Students' Activities: The students pay attention to the explanation of the types of soap and construct their own maps.

STEP II

The teacher explains the uses of soap to the students using concept map as follows:



Students' Activities: The students pay attention to the teacher, construct their own maps and ask questions where necessary.

STEP III:

Teacher activities: She carries out a massed repetition. Make clarification as the needs of the students may demand.

Students' activities: They go through their maps as the teacher goes through the entire exercise. Ask their questions.

STEP IV:

Evaluation

Teacher's Activities: The teacher evaluates the student on the following:

1. Identify at least three (3) uses of soap.
2. Say the difference between fats and oils.
3. Say the difference between liquid and solid soaps.

Students Activities: They answer questions and receive reinforcements and corrections.

CLOSSURE:

Teacher's Activities: She gives the students brief summary based on the day's topic and thanks the whole class for their active participation. She concludes by giving the students assignment:

(i) Identify and explain the major differences b/w Soft and Hard Soaps.

(ii) Why is Saponification process irreversible?

Students Activities: They jot down the salient points from the summary of the lesson, and copy the assignment the teacher gives.

Skill Emphasized: Questioning

Step VI: Summary and conclusion

Skill Applied: Closure.

LESSON 4

CONCEPT MAPPING ON ESTERIFICATION

Class: SS 3

Age: 15-17 years

Duration: 2 periods of 40mins each

Topic: Concept of Esterification

SPECIFIC OBJECTIVES:

By the end of this lesson, the Students should be able to

1. Define the term Esterification
2. Relate esterification to neutralization reaction

ENTRY BEHAVIOUR:

The Students can explain neutralization reactions

Introduction

Teacher: Asks them to define neutralization reactions.

Students' Activities: They answer the question asked by the teacher.

Teacher: He reinforces, relates it to Esterification and introduces the lesson. Briefs the students on the nature of concept mapping with regards to the concept of Esterification. This map is aimed at illustrating the meaning esterification, as the process of production of Esters. It will also illustrate the properties of esters and its uses.

The teacher takes the students through the concept as follows (prior to the Concept mapping exercise):

Students' Activities: They put down the topic of the lesson in their notebooks.

Step II: Definition of Esterification.

Teacher's Activities: The teacher leads the students to define esterification as the reaction between alkanol and acid in the presence of a mineral acid to form salt known as ester or alkanoate and water. She repeats the definition for clarification and writes the equation of esterification with example of the reaction on the chalkboard as:

Alkanol + Alkanoic Acid $\underset{\text{Hydrolysis}}{\overset{\text{Esterification}}{\rightleftharpoons}}$ Ester + Water (alkanoate).

Example: $CH_3CH_2OH + CH_3COOH \xrightarrow{\text{esterification}} CH_3COOC_2H_5 + H_2O$

(ethanol) (ethanoic acid) $\xleftarrow{\text{hydrolysis}}$ (ethylethanoate) (Water)

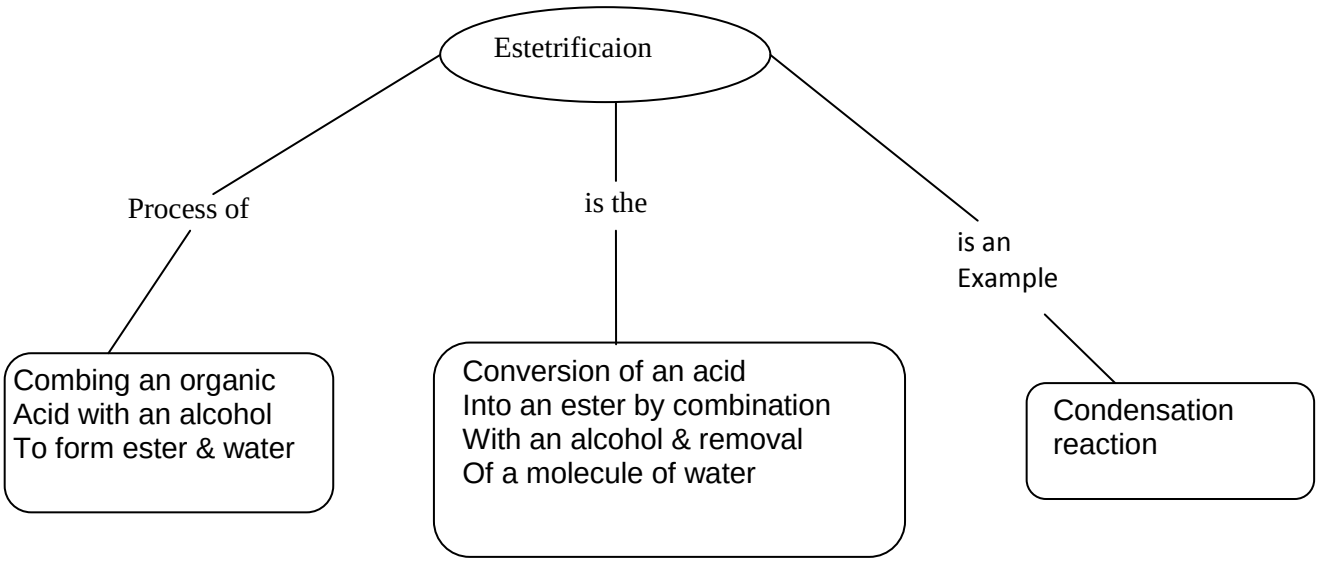
Students' Activities: They listen very attentively to the teacher, ask questions where they do not understand and jot down the equations as the teacher takes them through the stages.

Skill Emphasized: Questioning verbal communication, planned repetition, example.

Step 1: Definition of esterification

Mode: Whole class

Teacher's Activity: The teacher leads the student to define concept of esterification using concept maps as follows:



Student's Activity : They listen prepare their own maps and ask questions where they are confused.

Skill Applied: Verbal and non-verbal cueing.

Teacher activities: She carries out a massed repetition. Make clarification as the needs of the students may demand.

Students' activities: They go through their maps as the teacher goes through the entire exercise. Ask their questions.

STEP IV:

Evaluation

Teacher's Activities: The teacher evaluates the student on the following:

1. Define the term Esterification
2. Relate esterification to neutralization reaction

Students Activities: They answer questions and receive reinforcements and corrections.

Teacher's Activities: He reinforces and adjourns the class for process of esterification

LESSON 5

Class: SS 3

Age: 15-17 years

Duration: 2 periods of 40mins each

Topic: Process of Esterification

SPECIFIC OBJECTIVES:

By the end of this lesson, the Students should be able to

1. Explain the process of esterification.

2. Explain the process of esterification using relevant equations

ENTRY BEHAVIOUR:

The Students can define esterifiction

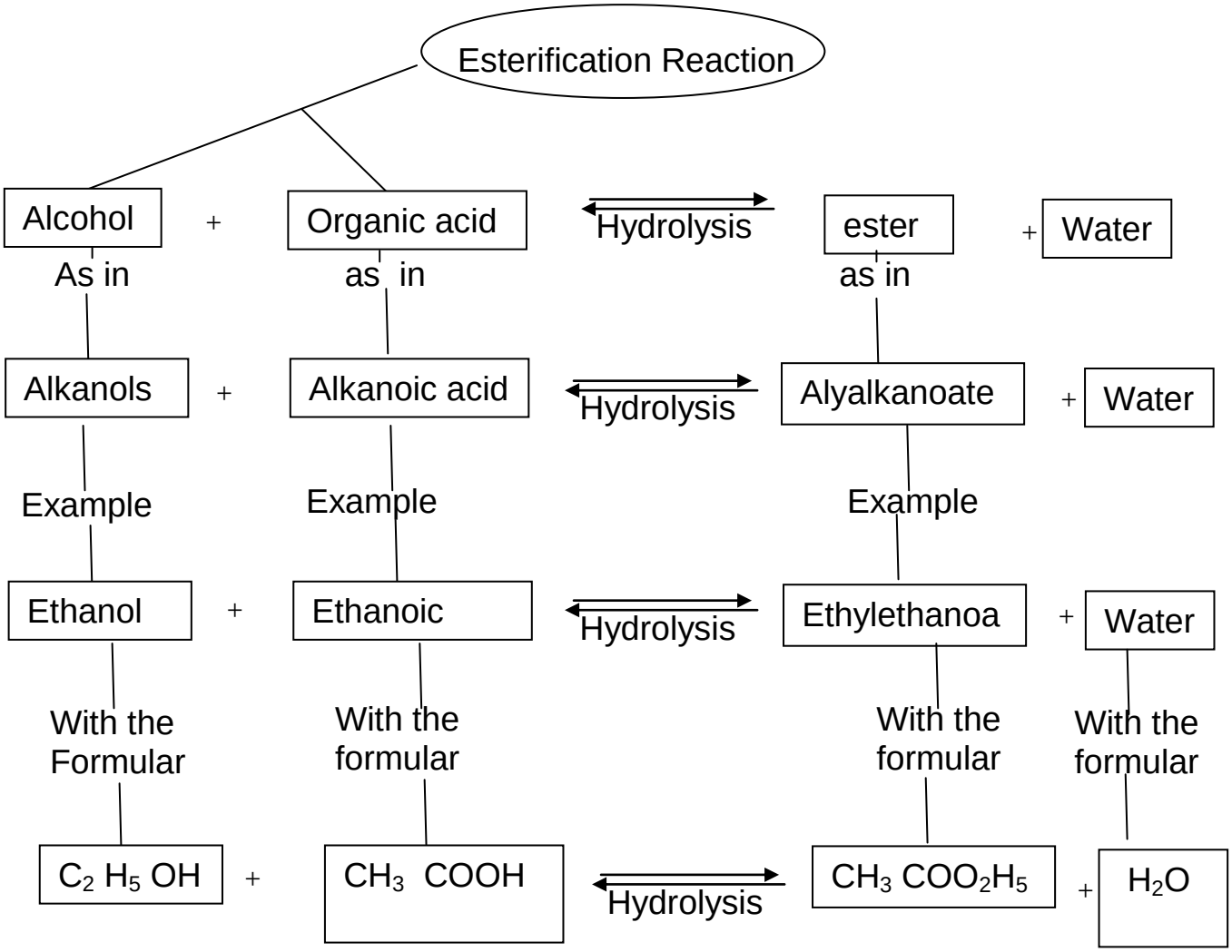
INTRODUCTION

Teacher: Asks them to define esterifiction

Students' Activities: They answer the question asked by the teacher

Teacher: He reinforces and introduces the lesson

He explains the process of esterification using Concept map as follows:



Students' Activities: The students pay attention to the teacher, construct their own maps and ask questions where necessary.

Step iv:

Teacher activities: she carries out a massed repetition of the concept mapping exercise. Make clarification as the needs of the students may demand.

Students' activities: They go through their maps as the teacher goes through the entire exercise. Ask their questions.

Step iii: Evaluation

Teacher's Activities: The teacher answers the student's questions and evaluates them with following questions:

1. Explain the process of esterification
2. Give the name of the reverse of esterification

Students Activities: They answer the teacher's questions.

Skill Applied: Questioning

Step vi: Summary and conclusion

Teacher's Activities: she gives the students a brief summary based on the day's topic and thanks the whole class for their active participation.

She concludes by giving assignment:

Draw the apparatus for the preparation of ethyl ethanoate.

Carry out a massed repetition, answer student's questions and adjourn the class

Students Activities: They jot down the salient points from the summary of the lesson, and copy the assignment given by the teacher.

Skill Applied: Closure.

LESSON 6
CONCEPT MAPPING ON ESTERIFICATION.

Class: SS 3

Age: 15-17 years

Duration: 2 periods of 40mins each

Topic: Properties of Ester and their uses.

SPECIFIC OBJECTIVES:

By the end of this lesson, the Students should be able to

1. Give at least two physical and chemical properties each of esters.
2. Outline 3 uses of esters.

ENTRY BEHAVIOUR:

The Student can explain the process of esterification

INTRODUCTION

Teacher: Asks them to explain the process of esterifiction

Students' Activities: They answer the question asked by the teacher

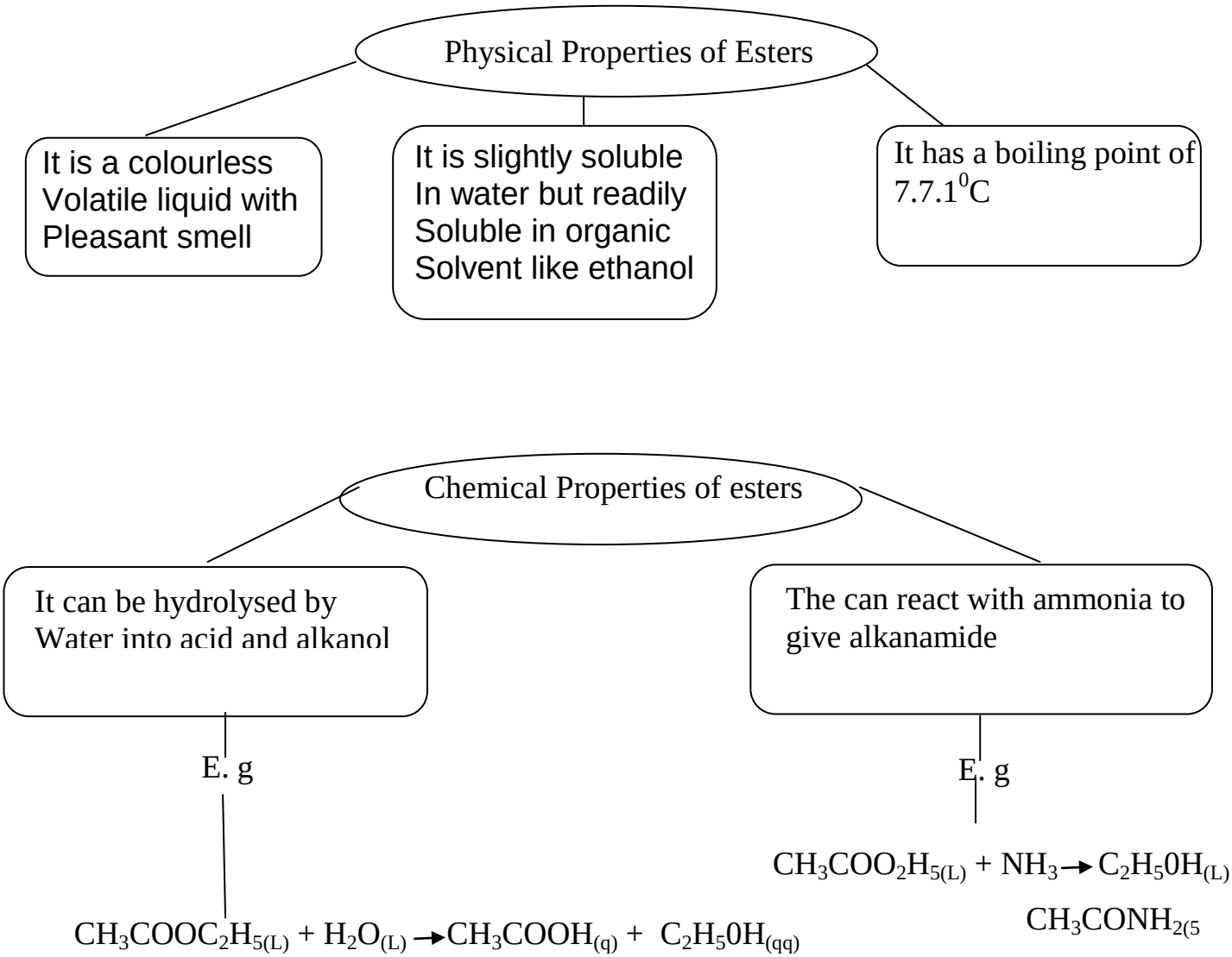
Teacher: The teacher reinforces and introduces the lesson. He briefs the students on the nature of concept mapping with regards to the properties of esters and its uses.

The teacher takes the students through the concept as follows

Step III: Properties of Esters

Mode: Whole class

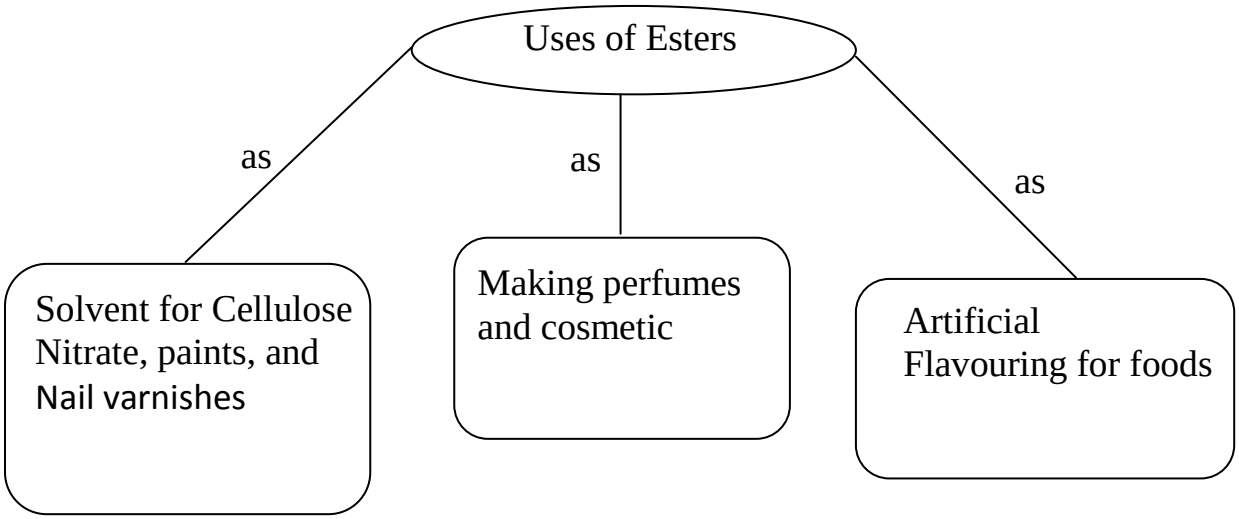
Teachers' Activities: The teacher explains to the students the various properties of asters using concept map as follows:



Students Activities: They pay attention to the teacher, ask questions where necessary and construct their own concept map of the properties of esters.

Skill Applied: Verbal and non-verbal cueing, explanations, use of example.

Step iv: The teacher illustrates the uses of esters using concept map as follows:



Students' Activities: The students pay attention to the teacher, construct their own maps and ask questions where necessary.

Step iv:

Teacher activities: she carries out a massed repetition of the concept mapping exercise. Make clarification as the needs of the students may demand.

Students' activities: They go through their maps as the teacher goes through the entire exercise. Ask their questions.

Step v: Evaluation

Teacher's Activities: The teacher asks the following questions

1. State two uses of esters
2. Identify three properties of esters.

Students' Activities: They answer the teacher's questions.

Skill Applied: Questioning

Step v: Summary and conclusion

Teacher's Activities: she gives the students a brief summary based on the day's topic and thanks the whole class for their active participation.

She concludes by giving assignment.

Discuss the importance esters to the chemical industry

Carry out a massed, repetition, answer student's questions & adjourn the class.

Students' Activities: They copy the assignment given by the teacher, and jot down the salient points from the summary of the lesson.

Skill Applied: Closure

PERIODS 7, 8 and 9 FOR SIMULATION PLAY LESSONS ON SAPONIFICATION,

Class: SS 3

Age: 15-17 yrs

Time: 3 periods of 80 mins each

Topic: Saponification

SPECIFIC OBJECTIVES:

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

i Define Saponification,

ii Explain fats and oils with examples

iii Explain the process of Saponification using relevant equations

iv Outline the properties of soap.

v. Mention and explain the two types of Soap

vi. Give at least 3 uses of Soap

Entry Behaviour: Student can define and identify fats and oils, and caustic solutions.

PERIOD 7 (80 mins)

Introduction:

The teacher introduces the lesson and briefs the students on the nature of simulation game with regards to saponification. The game is aimed at illustrating the meaning of saponification, its process and the production of soap. The game will also illustrate the properties of soap and its uses.

The teacher takes the students through the concept of as follows (prior to the simulation game proper):

STEP I: Asks them to define fats and oils, and describe the caustic solutions, reinforce and relates them to saponification and introduces the lesson. They are then shared into cast for their roles in step III Simulation game on Saponification for the experiment

Students are then shared into casts for their roles in step III.

Teacher's Activities: The teacher enters the class, with groundnut oil, lard and soap. She writes the date and subject of the lesson on the chalkboard and then asks the students to identify these substances before you? As the students raise their hands, the teacher points on few of them to answer the question. As the students mention groundnut oil, fats, soap……. She commends their efforts and explains further that fats and oil do undergo some reactions or processes to produce soap and that will lead them to the topic "Saponification". She writes the topic on the chalkboard as saponification.

Students Activities: They answer questions, put down the topic in their notebooks.

Skilled emphasized: Set induction, questioning, reinforcement.

Step II: Definition and process of Saponification

Teacher 's Activities: She leads the students to define saponification as:

The general process of alkaline hydrolysis of esters by which soap is obtained. An example is the hydrolysis of facts and oils with caustic alkaline to yield propane 1,2,3_ triol (glycerol) and the corresponding sodium or potassium salts of the components, fatty acids which is the soap. The teacher repeats the definition and illustrates the process as follows:

Fats and oils + Caustic alkali -Soap + Propane 1, 2, 3 – triol (glycerol)

$$\begin{array}{lcll} R^{I}COOCH_2 & & R^{1}COO - Na^{+} & HO - CH_2 \\ R^{II}COOCH & + \quad 3NaOH & R^{II}COO - Na^{+} & + \quad HO - CH \\ R^{III}COOCH_2 & & R^{III}COO\text{-}\ Na^{+} & HO - CH_2 \end{array}$$

Fats and oils Caustic Alkali Soap Propane 1, 2, 3 - triol (glycerol)

Students' Activities: They jot salient points and the equation on the chalkboard and ask for clarification where they do not understand.

Teachers' Activities: Adjourns the class for the simulation game proper and enjoins all the casts to prepare very well.

PERIOD 8 (80 minutes)

Simulation game proper:

Introduction:

The teacher informs the students that for proper capture of the concept, it will be presented in form of a play or drama called simulation game by few students. She gives the students necessary instructions concerning

the game. She also motivates the students on the need of them to be serious with the game by participating actively, maintaining absolute tranquility, listening and watching very attentively.

The teachers, having assigned the game personae on their roles before the day of the lesson, then introduce them to the whole class as follows;

Student A - Fats

Student B - Oils

Student C - Caustic soda (caustic alkali)

Student D - Soap

Student E - Glycerol

The teacher at once declares the game open.

Student Activities:

Student A -(Approaches immediately in front of the stage). As you all can see, I am fat, a bona fide member of lipids and course an ester. I am solid at room temperature and mainly from animal origin, though I can be synthesized from vegetable oil on rare bases. I melt at high point because of the high proportion of esters of saturated fatty acids in me. I can never be dissolved by water but only need organic solvents like carbon disulphide, chloroform, carbon tetrachloride to dissolve among others. You can identify me as butter, and lard from animal origin, or as

vegetable oil and coconut oil from plant origin. As a matter of fact, I can react with caustic alkali to produce soap and glycerol.

Student B- (Also approaches in front of the stage). I am oil, a beloved sister to fat, but liquid at room temperature and mainly from plant origin, though there are exceptions where I am synthesized from animal origin. I melt at lower points because of higher proportion of esters of unsaturated fatty acids in me. I am also not dissolved in anyway by water but can be dissolved by organic solvents like carbon disulphide, chloroform, carbontetrachloride and so on. I am also insoluble in alcohol but sparingly soluble in hot alcohol. I can be identified as linseed oil, groundnut oil, cashew oil, olive oil, almond oil, etc from plant origin or as Cordelier oil, whale oil, fish oil etc, from animal origin.

Chemically, I am hydrogenated in the presence of finely of divided nickel catalyst at a temperature of 200^0C and 5 atmospheres to produce solid fats known as Margarine. I can as well react with caustic alkali to produce soap and glycerol.

Student C- (Approaches in front of the stage). I am caustic soda (NaOH), an alkali. I am liquid at room temperature. In my real nature, I am colourless and odourless. In all forms, I am highly corrosive and reactive, and that is why I can react with facts and oils to produce soap and glycerol.

Student A and B: Oh since you can react with us and we can react with you, let us do so now….. (three of them collide and the light fades. The light returns and students D and E join the game). Vegetables on rare bases. I melts at higher points because of higher proportion of esters of saturated fatty acids in me. I can never be dissolved by water but only need organic solvents like carbondisulphide, chloroform, carbontetrachloride ($CC1_4$), among others to dissolve me. You can identify me as butter, and lard from animal origin, or as vegetable ghee and coconut oil from plant origin.

As a matter of fact, I can react with caustic alkali to produce soap and glycerol.

Student B – (Also approaches in front of the stage). I am oil, a beloved sister to fat, but liquid at room temperature and mainly from plant origin, though there are exceptions where I am synthesized from animal origin. I melts at lower points because of higher proportion of esters of unsaturated fatty acids in me I am also not dissolved in anyway by water but can be dissolved by organic solvents like solvents like carbondisulphide, chloroform, carbontetrachloride and so on. I am also insoluble in alcohol but sparingly soluble in hot alcohol. I can be identified as linseed oil, groundnut oil, cashew oil, olive oil, almond oil, avocado oil, etc from plant origin or as cordliver oil, whale oil, fish oil etc, from animal origin.

Chemically, I am hydrogenated or hardened in the presence of finely divided nickel catalyst at a temperature of 200^0C and 5 atm to produce solid fats known as Margerine. I can as well react with caustic alkali to produce soap and glycerol.

Student C – (Approaches in front of the stage). I am caustic soda (NaOH), an alkali. I am liquid at room temperature. In my real nature, I am colourless and odourless. In all forms, I am highly corrosive and reactive, and that is why I can react with facts and oils to produce soap and glycerol.

Student A and B: Oh since you can react with us and we can react with you, let do so now …….. (three of them collide and the light fades. The light returns and students D and E join the game.

Student D: Oh what a surprising reaction between fats and caustic soda to produce me. I am a hybrid). I am soap, the sodium salt of the component fatty acids. I am proud of myself because of my usefulness that the world cannot do without me. Among other uses, I am used as surfactants for washing. All of you here use me for bathing and all other form of washing. I am used in textile spinning and serve as impotent component of lubricants.

Student E- (approaches in front of the stage). I am propane I,2,3, triol but my nick name is glycerol. Despite the fact that I am a by-product, I have thousands of uses to all and sundry. Among other uses, I am used

as moisturizing agent, as a basic ingredient in the gums and resins used to make many modern protective coatings such as exterior house paints, as protective medium for freezing red blood cells, sperm cells, eye corneas and other living tissues. (the game ends).

Teacher's Activities: The teacher summons a big applause for the students who participated in the game and highly commends their efforts as well as the efforts of the whole class for their active participation. Adjourns the class for debriefing.

PERIOD 9 (80mins)

Debriefing and General discussion on Saponification

She them guides the students to reflect on and analyze the whole activities pointing out the important facts they learnt from the exercise.

Student's Activities: They pay attention, listen attentively, make contributions, note salient points in their notebooks and receive clarification where necessary

Skills Emphasized: Simulation game, reinforcement, verbal communication, questioning.

Step v: Evaluation

Teacher's Activities: The teacher evaluates the student on the following:

1. Define Saponification

2. Identify two conditions necessary for saponification to occur

3. Write the equation for saponification

4. Mention the types soap

5. Explain fats and oils with examples

6. Identify at least three (3) uses of soap

Students Activities: They answer questions.

Skill Emphasized: Questioning

Step V: Summary and conclusion

Teacher's Activities: Reinforces, give corrections and a brief summary based on the day's topic and thanks the whole class for their active participation. Adjourns for esterification.

PERIODS 10,11and12 FOR SIMULATION PLAY LESSONS ON ESTERIFICATION

Class: SS 3

Age: 15-17 years

Duration: 3 periods of 80mins each

Topic: Esterification

SPECIFIC OBJECTIVES:

By the end of this lesson, the Students should be able to

1. Define the term Esterification

2. Explain the process of esterification using relevant equations

3. Give at least two physical and chemical properties each of esters.

4. Outline 3 uses of esters.

ENTRY BEHAVIOUR:

The Student can explain neutralization reactions.

PERIOD 10 (80mins)

Introduction:

The teacher introduces the lesson and briefs the students on the nature of simulation game with regards to the concept of Esterification. This game is aimed at illustrating the meaning of esterification, its process of and the production of Esters. It will also illustrate the properties of esters and its uses. He directs them on the use the role cards earlier given to them.

The teacher takes the students through the concept as follows (prior to the simulation game):

Teacher: Asks them to define neutralization reactions.

Students' Activities: They answer the question asked by the teacher.

Teacher: Reinforce. Relates it to Esterification and introduces the lesson.

Students are then shared into casts for their roles in step III

Students' Activities: They answer the question asked by the teacher and put down the topic of the lesson in their notebooks.

Skills Emphasized: Questioning, reinforcement.

Step II: Definition of esterification, and process of esterification

Teacher" Activities: The teacher leads the students to define etherification as the reaction between alkanol and acid in the presence of a mineral acid to form salt known as ester or alkanoate and water. She repeats the definition for clarification and at once writes the equation of etherification with example of the reaction on the chalkboard as:

Alkanol + Alkanoic Acid $\underset{\text{hydrolysis}}{\overset{\text{esterification}}{\rightleftharpoons}}$ ester + Water (alkanoate).

Example: $CH_3CH_2OH + CH_3COOH \underset{\text{hydrolysis}}{\overset{\text{esterification}}{\rightleftharpoons}} CH_3COOC_2H_5 + H2O$

(ethanol) (ethanoic) (acid) (ethylethanoate)

Students' Activities: They listen very attentively to the teacher, ask questions where they do not understand and jot down the equations as the teacher takes them through the stages.

Teacher: Adjourns the class for simulation game proper and enjoins all the casts to prepare very well for their roles

Skill Emphasized: Questioning verbal communication, planned repetition, example

PERIOD 11 (80 mins)

THE SIMULATION GAME PROPER.

Teacher's activities: The teacher as the instructor gives the students necessary instructions concerning the game. She motivates the students on the need for them to be serious with the game. She also tells the

students to maintain absolute tranquility, listen attentively and watch out for the game. The teacher having assigned the game personae their whole before hand, then introduces them to the whole class as:

Student A - Ethanol
Student B - Ethonoic acid
Student C - Ethylethanoate (ester)
Student D - Water

The teacher then declares the game open.

Student's Activities: Student A – (Approaches immediately and stands in front of the stage). As you all can see, I am ethanol, a bonafide member of alkanols. I was prepared from ethane by hydration of ethane. Now I have been very useful to all and sundry as a solvent for the production of perfumes, varnished, soaps, points, dyes, drugs and flavouring extracts. Not only that, I serve as a starting material in the manufacture of many important compounds like ethanol, ethanoic acid, ethylester and so on. I also render myself to be used by all and sundry as a fuel and as an anti-freeze in automobile radiators. As an antiseptic, many doctors use me as surgical spirits for hardening skins and in the treatment of your principles. As reactive as I am, I can react with other substances like ethanoic acid……

Student B. (Comes out immediately) ah who mentioned by name? of course, I am ethanoic acid, a bonafide member of alkanoic acid family. I was prepared by the complete oxidation of ethanol by acidified

sodiumheptaoxodichromate (iv) solution ($Na_2 C_2 O_7$). As a mater of fact, I am very useful to the whole world as a solvent in food industry, there I serve as vinegar for preserving and flavouring food. Many people also use me in making propanone and dyes. Not only that I made myself available for people to be used for coagulating rubber. To crown it all, I can actively take part in reaction to reproduce other compounds when combined with other substances like ethanol……..

Student A: Oh since we can combine, let's do so now.. (Both of them then collide and the light fades. The light returns and students C and D join the game).

Student C: Oh what a wonderful reaction between ethanol and ethanoic acid to produce me. I am a hybrid. I am ethylethanoate an ester. As a matter of fact I am responsible for the fragrance of flowers and the flavours of fruits though I am colourless and volatile. I am only slightly soluble in water but can dissolve readily in any organic solvent. Bear this in mind, I boil at 75^0C.

As a chemical, I can be hydrolyzed by water to reproduce my producers (i.e. Ethanol and ethanoic acid) and that will be a backward or reverse reaction known as hydrolysis. I can also react with ammonia to give birth to ethanol and ethanamide (an amide). I can as well accept to be reduced to ethanol by hydrocarbon from a strong reducing agent like Lithiumtetra-hydridoaluminate ($LiALH_4$).

As I am taking to you now, my usefulness cannot be overemphasized because I am very useful as solvents for cellulose nitrate and quick-drying substances like paints, lacquer, nails – varnishes and adhesives. Most people including you, use me as perfumes and cosmetics and as artificial flavouring of foods.

Student D: (Comes out and says) – You can see I am water which the whole world cannot do without. To cut it short I am the universal solvent both inside the laboratory and outside the laboratory. (The game ends).

. **Teacher's Activities:** The teacher summons a big applause for the students who participated in the game and highly commends their efforts as well as the efforts of the whole class for their active participation.

PERIOD 12 (80mins)

Step iv: Debriefing and General Discussion on esterification

She them guides the students to reflect on and analyze the whole activities pointing out the important facts they learnt from the exercise.

Student's Activities: They pay attention, listen attentively, make contributions, note salient points in their notebooks and receive clarification where necessary

Skills Emphasized: Simulation game, reinforcement, verbal communication, questioning.

Step V: Evaluation

Teacher's Activities: The teacher asks the following questions

1. Define esterification
2. Give the name of the reverse reaction of esterification
3. State two uses of esters
4. Identify three properties of esters.

Students Activities: They answer the questions of the teacher.

Skill Applied: Questioning

Step Vi: Summary and conclusion

Teacher's Activities: Reinforces, gives a brief summary of the concept and thanks the whole class for their active participation. Asks the students to prepare for a test the next day.

APPENDIX K

Dept of Science Education

NnamdiAzikiwe University

Awka

Anambra State

10th Sept, 2013

The Principal,

Dear Sir,

LETTER OF PERMISSION

I, **Mr. P.I.I. Ikokwu** is a PhD student of the above university. I am conducting a research on the effectiveness of concept mapping and simulation game as advance Organizers in the teaching of Organic Chemistry. I am requesting the use of your SS3 Chemistry Students for this academic purpose. It will not deviate from the normal Scheme and content in your School and will not disrupt, in any way, your class structure or arrangement. I will highly appreciate if my request is granted. Thanks

Yours faithfully,

Ikokwu, P.I.I.

APPENDIX L

THE TRAINING PROGRAMME

The training manual was predominantly the notes of lessons.

DAY 1

The teachers were taken through the entire experimental procedure. The researcher gives explanations on the purpose of the research and the various groups involved. They are concept mapping group (CMG), simulation game group (SGG) and the lecture method group. The reasons for involving these groups are presented by the researcher as components of the experimental procedure. The pretest posttest posture of the experiment is then highlighted. Emphases are then made and questions from them answered.

DAY 2

The detailed notes of lessons are presented to the research assistants. They are taken through the 1st and 2nd lessons on saponification according to methods to be used the various schools. The specific characteristics of each method or group are emphasized. Emphases are then made and questions from them answered.

DAY 3

The researcher takes the assistants through the 3rd and 4th lessons which are on esterification as it concerns each group.

Their questions are taken and clarification given until they indicate readiness for the experiments.

APPENDIX M

Department of Science
Education Nnamdi
Azikiwe University,
Awka,
20th May, 2013

Dear Sir/Ma,

REQUEST FOR VALIDATION

I am Ikokwu, Peter I.I. Reg No. 2009607003P, Department of Science Education, Unizik Awka. I am working on the topic: Comparative Effectiveness of Concept Mapping and Simulation Play on the Interest and Achievement of Students in Organic Chemistry.

Sir/Ma, with due respect, I present the accompanying instrument to you for validation of its content and construct.

1. Chemistry interest inventory (OCSII)
2. Lesson plans.

Also attached to assist you are:

1. The research questions
2. The hypotheses

The following topics were treated:

1. Saponification
2. Esterification

Thanks for your anticipated co-operation.

Your sincerely,
Ikokwu Peter I.I
08068686868