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Using Molecular Model Set to Improve Academic Performance in Naming Organic Compounds at Effiduase Senior High School, Sekyere East District, Kumasi.

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By

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DECLARATION

STUDENT DECLARATION

I, Harriet Gyasi declare that this dissertation, with the exception of quotations and references contained in published works which have all, to the best of my knowledge, been identified and acknowledged, is entirely my own original work, and it has not been submitted, either in part or in whole, for the award of another degree elsewhere.

SIGNATURE ………………….

DATE………………………….

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this dissertation was supervised in accordance with the guidelines for supervision of dissertations laid down by the University of Education, Winneba.

NAME OF SUPERVISOR………………………………..

SIGNATURE……………………………………………

DATE...

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DEDICATION

This work is dedicated to God for sustaining me throughout the study and also to my dear husband Kingsley Osei-Bonsu and my children Akua Akyaa Osei-Bonsu and Abena Frimpomaa Osei-Bonsu, for their prayers and support.

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ABSTRACT

This research was primarily designed to help improve students' academic performance in naming organic compounds using molecular model set in Effiduase Senior High School in the Sekyere East district of the Ashanti Region.

Experimental design was used for this study where the form three science classes were put into two groups. Science one students formed the control group and were taught using traditional approach while the science two students comprised the experimental group and were taught using the molecular model set. An independent-sample t-test analysis was used to analyse the scores from the tests to show the impact of molecular model set teaching strategy on students' academic performance. The mean value of the pre-intervention test was 25.32 (SD=2.659) and that of the post-intervention test was 36.02 (SD=4.51). The mean values showed that there was an improvement in the academic performance of the students in the experimental group. In the independent-sample T-test, the p-value ($p = 0.000 < 0.05$), meaning that there was a significant difference in academic performance between the students in the experimental group and that of the control group. The performance of gender was also checked and the results from this study showed that in both the pre-and post-tests for both experimental and control group, the male students performed better in all aspect of the tests. The independent sample t-test analysis gave a p-value of 0.000 (α=0.05) showing that there was statistically significant difference between the mean scores of the male students and the mean scores of the female students. It was concluded that the use of molecular model set teaching approaches should be integrated into teaching of challenging chemistry concepts at the senior high school level in Ghana.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter looks at the background to the study, statement of the problem, purpose of the study, research objectives, research questions and hypothesis. The rest are the significance of the study, delimitations, limitation, and organization of the study.

1.1 Background to the study

According to Johnstone (2006), chemistry is a difficult subject for students. The difficulty may lie in the capabilities of human learning as well as in the intrinsic nature of the subject. The fact that students have difficulty learning chemistry has been well documented. (Gabel and Bunce, 1994), attributed student's difficulty in learning chemistry to a variety of factors such as, the abstractness of the subject and the different representational levels that chemist's use, (Nakhleh and Kracjik, 1994). Thus it is of major importance that anyone teaching chemistry is aware of the areas of difficulty.

It has been observed that most students fear chemistry and hence wrongly perceived chemistry as difficult to understand. It was equally observed that many factors such as poor teaching methods, mathematical and abstract nature of chemistry concepts and laws account for students' poor performance (Njoku, 2005). The following characteristics among others encourage effective teaching processes; a good knowledge of the subject matter, understanding of basic principles of child development, ability to employ different effective teaching strategies, and ability to adopt teaching to suit local situation (Danmaigoro,2005). Chieu (2005) concluded that chemistry is a world filled with interesting phenomena, appealing experimental activities and fruitful knowledge for understanding the natural and manufactured world.

Even though there is strong emphasis on organic chemistry (Coll, 2004) students commonly consider it the biggest obstacle. Most students find science difficult, especially physical sciences such as chemistry and physics. Many students are reading chemistry, not by choice but because it is a required as part of the programme they pursue. Such students have low interest in studying chemistry (Coll, 2004). Chemistry students find it hard to connect the molecular formula, the geometric structure and the molecular characteristics of a compound or molecule together (Johnstone, 1997). Understanding the particulate nature of matter and interpretation of symbols and visualizing spatial orientation of atoms in molecules are essential skills students need to know in solving problems in chemistry in general and organic chemistry in particular.

Organic chemistry is difficult from many students point of view and their performance in this subject is relatively poor. Although the study of organic chemistry is complex, yet it is important not only to those who are interested in science or related careers, but also to every individual living today and to those who will be born in the future. Addison and Wesley (2004) concluded that organic chemistry is a key in developing new products and improving upon those on which we have become dependent.

The West African Examination Council Chief Examiners report (July / August 2004, May / June 2006) on SSSCE and WASSCE revealed the candidates' weakness in organic chemistry (e.g. Candidates were not able to define relevant terms in organic chemistry). They were not able to give correct IUPAC names of some compound and could not draw the structures nor give isomers of some compounds let alone state the industrial application of them. To help students understand chemistry, teachers should develop new approaches to teaching chemistry 'such as adapting teaching strategies based on the conceptual change model, presenting the historical change of a theory, using concrete models, and using technological tools (Krajcik, 1999). For instance, multimedia tools, which integrate the animation of molecular models, video clips of chemical equilibrium, or real time graphics, provide students with opportunities to visualize chemical processes at the microscopic level. While empirical studies assert the value of using teaching models and technological tools for chemistry learning, however, little is understood about how teaching models actually support students' learning; how students' use these teaching models evolve over time in classroom settings, and what features of a technological tool help students to develop conceptual understanding of chemical representations. The learner can only be motivated to engage in science only if it is of interest and value. The purpose of using molecular model sets as teaching and learning materials fits in to the ideas of constructivism. It excites and maintains the interest of students, ensures practical work, enables learners to acquire skills and ensures acquisition of first-hand information. As students learn by building and naming various molecules, they become actively engaged in experience-based learning which is one of the key to the construction of new knowledge (Merriam, Caffarella, & Baumgartner, 2007).

1.2 Statement of the Problem

Chief Examiners' Reports have consistently indicated candidates' weakness in naming organic compounds. The report indicated their inability to write the correct names and structures of the organic compounds. The WAEC Chemistry Chief Examiner's report in Ghana has continuously commented on the poor performance of most students in IUPAC naming of organic compounds. The Chief Examiner's report 2001 showed that many students attempted a question on naming of organic compounds but some candidates could not give the IUPAC names of the compounds. According to the 2002 and 2006

WAEC chief examiner's report, candidates showed weakness in IUPAC naming of simple organic compounds .According to Adu-Gyamfi, Ampiah and Appiah (2012), as well as Krajcik and Soloway (2001) studies revealed that students have difficulties in the use of IUPAC nomenclature systems.

In general, the students showed weakness in IUPAC naming and writing of structural formulae of Alkenes, Alkynes, Alkanols, Alkanoic acid and Alkyl alkanoates (Adu-Gyamfi *et al*., 2012).

The problem with IUPAC nomenclature has also been reported with students elsewhere in the world. For example, study conducted by O'Dwyer and Childs (2010) in Ireland revealed that Second Level Irish Pupils have difficulty in naming and writing of formulae of organic compounds, also a study conducted by Gondgden *et al* 2011 in Nigeria indicated that IUPAC nomenclature of organic compounds is one of the difficult topics in Senior Secondary School syllabus. Apart from students' difficulty in naming organic compounds the styles of teaching strategies in teaching students also contributes to poor academic performance of students. There is therefore the need to find out the sort of misconceptions or alternative ideas students in Senior High Schools bring to chemistry class. Using molecular model set in naming organic compounds is a most effective instructional teaching approach to improve students' conceptual understanding and academic performance in the study of organic chemistry.

1.3 Purpose of the Study

In Ben-Zvi, Eylon, and Silberstein's study (1988), they explored what level of descriptions students generated (e.g., the macroscopic level, the atomic molecular level, the multi-atomic level), when some chemical symbols and formulae were used, such as

$Cu_{(s)}$, $H_2O_{(l)}$, and $Cl_{2\,(g)}$. Students' responses indicated that a majority of them confused atoms with molecules. Although most of them generated some macroscopic descriptions of water, i.e., its properties, the atomic-molecular models they used to explain the phenomena were not appropriate. Hence, the purpose of this study was to use molecular model set as the most effective instructional teaching approach in naming organic compounds to improve students' academic performance in the study of organic chemistry among Effiduase Senior High School students in the Ashanti Region of Ghana

1.4 Research Objectives

The study seeks to:

- Improve the academic performance of students in Effiduase Senior High School using molecular model set teaching strategy in naming Organic Compounds.
- Find out the extent gender influence the performance of the students in naming organic compounds after they are taught using molecular model set in Effiduase Senior High School.
- Influence positively the attitudes of Senior High School Students towards the naming of Organic Compounds through the use of molecular model set in Effiduase Senior High School.

1.5 Research Questions

The following research questions were addressed in the study:

1. To what extent does the use of molecular model set teaching strategy improve the academic performance of students in Effiduase Senior High School?

2. What influence does the use of molecular model set have on the attitudes of students in Effiduase Senior High School towards the naming Organic Compounds?
3. To what extent did gender influence the performance of the students in naming organic compounds after they are taught using molecular model set in Effiduase Senior High School?

1.6 Research Hypothesis

***H_o*:**

There is no significant difference in academic performance of students in Effiduase Senior High School using molecular model set teaching strategy in naming Organic Compounds.

1.7 Significance of the study

The findings from this study such as the difficulties students have with naming organic compounds at the SHS level could help Heads of SHSs, Heads of Science Departments and Chemistry teachers to create the conditions necessary for Chemistry students to overcome such difficulties. This study seeks to help chemistry teachers to adopt some effective teaching strategies in helping SHS Chemistry students to improve their understanding in the area of organic Chemistry.

The study would be useful to the Ghana Association of Science Teachers (GAST) in educating its members, especially chemistry teachers in adopting effective teaching method of naming organic compounds in their annual conferences or workshops. To curriculum developers and designers, the success of using the molecular models set in the teaching and learning of the IUPAC naming of organic compounds would give them a new perspective in recommending it use across the educational system.

1.8 Delimitation of the Study

The study was carried in Effiduase SHS. This was due to lack of funds, proximity of the researcher and also accessibility to the population. Also, due to the limited duration of the programme, two science classes were adopted in the school for the research to save time and cut down cost.

1.9 Limitation of the Study

This study like all other research work is not without limitation. Only third year students offering elective chemistry were considered. This was due to the fact that naming of organic compounds was studied by the third year students based on their syllabus.

1.10 Operational Definition of Terms

Control group –Refers to a group of students who were taught naming organic compounds using the traditional approach of teaching.

Experimental group- refers to a group of students who were taught naming of organic compounds using molecular model set.

Traditional Approach – refers to teaching concept by following what is in the textbooks without taking into considerations what the learner knows.

Pre-test - A test that will be given to students before exposing them to teaching method.

Post-test - A test that will be given to students after exposing them to teaching methods.

Molecular model sets- a set of plastic ball (of atoms) with projections and straws for building especially organic molecules.

1.11 Abbreviation

IUPAC - International Union of Pure and Applied Chemistry.

MOE - Ministry of Education.

SHS - Senior High School.

WASSCE- West African Senior School Certificate Examination

MOESS- Ministry of Education, Science, and Sports

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter looks at the theoretical framework of the study, Introduction to IUPAC system of naming, Ghana chemistry syllabus, students difficulties in writing IUPAC names, IUPAC naming from students perspectives, model sets in science classroom, pedagogical content knowledge in organic chemistry ,teachers and students attitude towards science and factors influencing gender performance in science .

2.1 Introductions

As applied theoretical and physical chemists, Hoffman and Laszlo (1991) claimed that representations in chemistry are metaphors, models, and theoretical constructs of chemists' interpretation of nature and reality. Chemical representations in this study refer to various types of formulae, structures and symbols used in chemistry. The drawing of molecular structures and the writing of chemical formulae are "ideology-laden" and "theory-laden" (Hoffmann & Laszlo, 1991) that convey messages of the development of chemical theories and experiments. Chemical representations thus are meaning-based knowledge representations, which are changed and created to reflect the reunification or reconstruction of the theoretical and the experimental.

2.2 Theoretical Framework of the Study

The theoretical framework of this study is focused on the constructivist theory of learning. Constructivist teaching practices are becoming more prevalent in teacher education programme and public schools across the Nation, while demonstrating significant success in promoting student learning (Davis and Sumara, 2002).

According to Good and Brophy (1994), Constructivist perspective is based on how learners construct their own understanding or meaning. Students manipulate, discover and create knowledge to fit their belief systems and new learning builds on prior knowledge. The construction of new knowledge in science is strongly influence by prior knowledge. Constructivists' theory deals with learning "a sa process of constructing meaning; it is how people make sense of their experience" (Merriam, Caffarella, & Baumgartner, 2007).For constructivists like Kincheloe (2000) and Thayer-Bacon Barbara (1999), knowledge about the world does not simply exist out there waiting to be discovered, rather it is constructed by human beings in their interaction with the world. They explain that, "the angle from which an entity is seen, the values of the researcher that shape the questions he or she asks about it, and what the researcher considers important are all factors in the construction of knowledge about the phenomenon in question". Thayer-Bacon Barbara (1999) emphasised that knowledge is constructed by people who are socially and culturally embedded, rather than isolated individuals. Constructivists believe that, what is deemed knowledge is always informed by a particular perspective and shaped by various implicit value judgments.

According to Windschitl Mark (1999), constructivism is based on the assertion that learners actively create, interpret, and reorganize knowledge in individual ways. These fluid intellectual transformations, he maintained, occur when students reconcile formal instructional experiences with their existing knowledge, with the cultural and social contexts in which ideas occur, and with a host of other influences that serve to mediate understanding. Gallagher (2000) said that students should realize that they have to construct their own knowledge whenever they are thought any scientific concept.

According to Swan (2005), constructivists are divided in the areas of focus though they all share common assumptions about the nature of learning and construction of knowledge. Some constructivists focus the student's knowledge construction on the social environment, physical, and mental world. Social constructivists agree that students construct knowledge through social interactions. Thus, psychologists of today recognise that culture shapes cognitive development by determining what and how the students will learn about the world (Swan, 2005; Woolfolk, 2007). a Russian psychologist, Lev Vygotsky, attributed a special role in cognitive development to the social environment of the student. That meaning is constructed by a student socially as he or she engages in activities, communicates, and interacts with others (Swan, 2005; Woolfolk, 2007). The student's social world (culture) determines which stimuli occur and are attended to and that knowledge constructed is not predetermined by innate factors.

Dirks (1998) explained that many schools have now realised that knowledge is not objective but constructed socially and that the knowledge constructed depends greatly on experience and interactions of the students with others who know it. Dirks (1998) emphasized that a student goes about the process of knowledge constructions through a mixture of experiences, perspectives, and interactions. Constructivism is opposed to passive learning approach where students normally take away content, and that knowledge construction should be an active engagement of the students (Dirks, 1998). Cognitive constructivists revealed that knowledge construction should be based upon the internal development of mental structures. Cognitive constructivists stressed on the students' knowledge, beliefs, and self-concept, and on the inner being of the student. The study framework, therefore could be seen to be organized on the principle that the student build or construct their own meaning of new information on the basis of their existing knowledge and that what a person brings to the learning environment matters. Constructivists hold the view that, learners understanding of school science to large extent are conditioned by their present common sense experiences (Dirks, 1998). This understanding in turn is shaped by their prior encounters with the various natural phenomena, even though their interpretation of such encounters may or may not be scientifically valid. In the construction process what a learner already knows or believes interact with a new conception to which the learner has been exposed.(Tobin, Tippins & Gallard, 1994). Thus, teacher with a constructivist view point can influence the understanding of their students and plan medicating events that assist students in moving from a current understanding which is not scientific (Brooks &Brooks, 1999; Driver, Asoko, Leach, Mortiner & Scott, 1994).

Teaching strategies using social constructivism as frame of reference relate to teaching in context that might be personally meaningful to student .These also involve negotiating understanding with students through class discussion in small as well as large groups of students (Dougiamas, 1998).The study is underpinned by cognitive, this is because the whole being of the learner is involved in construction of knowledge from the perspective of social constructivism discussed above. In other words, learning involves all the three: cognitive, psychomotor and affective domain and all the three are equally important in construction of knowledge.

2.3 Introduction to IUPAC System of naming organic compounds

Originally, the term Organic Chemistry referred to the study of chemical compounds present in living matters, but now it is defined in terms of the study of carbon compounds, which exclude simple ones such as oxides of carbon, carbonates, cyanides and cyanates (source). There are vast number of synthetic and natural organic compounds due to the uniqueness of carbon; such as catenation (Daintith, 1981), exhibition of tetra-valency and carbons ability to bond with other elements such as nitrogen, halogen, oxygen, and sulphur.

According to Solomons and Fryhle (2013), after the nineteenth century, there came a formal system for naming organic compounds. Formally, the names of those compounds were based on the respective sources of the compounds. For instance, a carbon compound from vinegar was named as acetic acid (in Latin: acetum for vinegar), formic acid obtained from some ants (in Latin: formicae) and hence the name, formic acid. Ethyl alcohol was once known as grain alcohol because it was obtained from fermented grains. These old names such as acetic acid, formic acid, and grain alcohol are currently referred to as 'common' or 'trivial' names (Solomons & Fryhle, 2013). Some of the carbon compounds (organic compounds) were also given trivial names by the scientists who discovered them. For example, acetylene (C_2H_2), benzene (C_6H_6), and acetone (C_3H_6O) (Gillette, 2004).

According to Gillette (2004), some organic compounds had more than one trivial name and hence brought confusion among chemists and biochemists during communication. The International Union of Pure and Applied Chemistry (IUPAC) in 1892 came out with the formal system of naming organic compounds and hence the name, IUPAC nomenclature (Gillette 2004; Heger, 2003; Solomons & Fryhle, 2013).

The IUPAC system has replaced the common names which had their origins in the history of science and the natural sources of specific compounds. The relationship of most of these former common names to each other was arbitrary, and no rational or systematic principles under laid their assignments (Brown & Foote 2002). The IUPAC naming system is a set of logical rules devised and used by organic chemists to avoid problems posed by arbitrary naming system. The use of the rules alongside the molecular models helps to write the structural formula, and to write a unique name for every distinct compound. According to (Daley & Daley, 2005: Zumdahl, 2000), in general, the IUPAC name will have three essential features:

- A root or base indicating a major chain or ring of carbon atoms found in the molecular structure.
- A suffix or other element(s) designating functional groups that may be present in the compound.
- Names of substituent groups, other than hydrogen, that completes the molecular structure.

According to Fessenden and Fessenden (1990), "the IUPAC system of naming is based upon the idea that the structure of an organic compound can be used to obtain its name and that a unique structure can be drawn for each name". The IUPAC system, which has been in use since 1892, has been revised many times. The current IUPAC rules of nomenclature were updated in 1993. From Solomons and Fryhle (2013), each different compound should have an unambiguous name. This serves as the basic principle of the IUPAC system where no organic compound will have more than one name. Any chemist or biochemist who is used to the rules of IUPAC system can write the correct name or structural formula of any organic compound .The IUPAC system of naming organic compounds is dependent on the functional groups, which is grouping compounds by shared structural features (Gillette, 2004). For instance, all Alkanoic acids contain the carboxyl (─COOH) group and Alkanols contain the hydroxyl (─OH) group bonded to carbon atom.

According to Clark (2000), Chemistry students can develop two skills in using the IUPAC naming system to name organic compounds. These are the ability to:

a. Draw or write the structural formula of an organic compound from its IUPAC name.
b. Write the IUPAC name of an organic compound from its structural formula.

According to Gillette (2004), there are three ways of representing the IUPAC names of organic compounds with structural formulae. These are expanded structural formula, condensed structural formula and the line-angle structure. The expanded structural formulae shows all the carbon and hydrogen atoms together with any other group of atoms and the covalent bonds joining them.

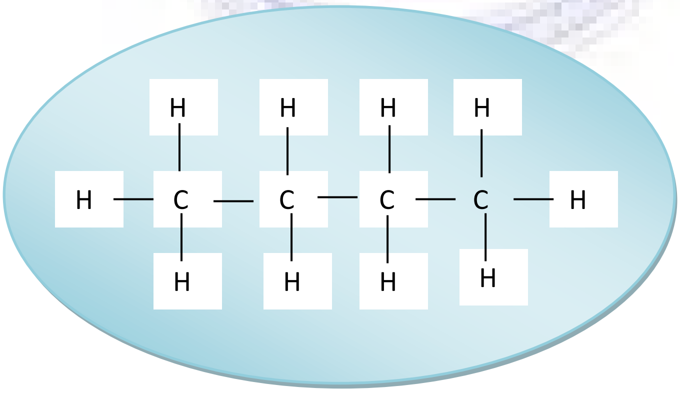

Figure 2.1: Shows expanded Structural Formula of butane.

The line-angle structural formulae use lines to show chemical bonds without the carbon and hydrogen atoms.

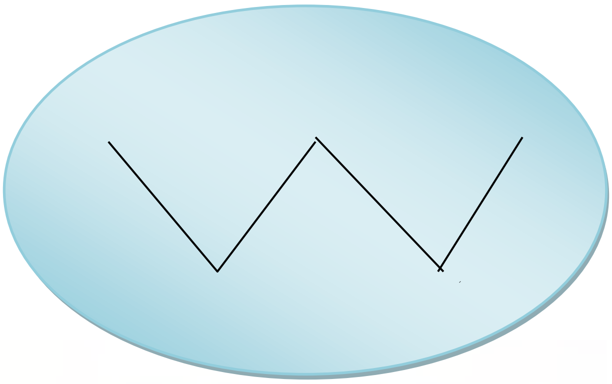

Figure 2.2: Shows a Line-angle Structural Formula of pentane.

The condensed structural formula shows any carbon atoms in the straight chain together with any other group of atoms connecting to the chain .Bonds/lines may be used to emphasise how the carbon chains are related.

CH_3-CH_2-CH_2-CH_2-CH_3 or $CH_3CH_2CH_2CH_2CH_3$(Daley & Daley, 2005)

Figure 2.3: shows condensed Structural Formula of butane

Clark (2000), explained that an IUPAC name of an organic compound is simply a code and that each part of the IUPAC name reveals some useful information about the compound. For example, ***2 -methylbutan-1-ol*** could be understood in the following ways:

1. The ***but-*** shows that, four carbon atoms are in the longest continuous chain (Clark, 2000).
2. The –***an*** comes immediately after the '***but***' shows there is carbon to carbon single bond (Clark, 2000).

3. The ***2-methyl*** and ***1-ol*** shows where the substituent and the functional group are located on the longest continuous carbon chain (Clark, 2000).

According to Clark (2000), one has to learn the codes for number of carbon atoms in the longest continuous carbon chain in order to name organic compounds. Examples of codes for the first five groups of carbon atoms are *Meth*, *Eth*, *Prop*, *But*, *Pent* for *1*, *2*, *3*, *4*, *5* carbon atoms respectively. Clark (2000) pointed out that if an organic compound contains a carbon-carbon multiple bond, the two letters that come immediately after the code for the chain will tell the type of bond that exist between the carbons. Example -***ane***, ***-ene***,***-yne*** indicate carbon-carbon single bond, carbon-carbon double bond and carbon –carbon triple bond respectively. Alkyl groups such as ***methyl*** (CH_3─), ***ethyl*** (CH_3CH_2─), and ***propyl*** ($CH_3CH_2CH_2$─) and non- alkyl groups such as ***I-iodo***, ***Br-bromo***, ***Cl- chloro***, ***F-floro*** are usually attached to the longest continuous carbon chain as substituent (Clark, 2000).

2.4 Ghana Chemistry Syllabus

In Ghana, one of the general aims of the Chemistry teaching syllabus is to help Chemistry students from SHS2-3 to appreciate and use the IUPAC system to name chemical compounds (Ministry of Education, Science, and Sports (MOESS, 2008). According to MOESS (2008), the IUPAC nomenclature of 17 carbon compounds are introduced at the SHS3 level under section 6 of the Chemistry teaching syllabus. The IUPAC nomenclature is studied under areas such as Alkanes, Alkenes, Alkanols, Alkanoic acids, and Alkanoic acids derivatives (for example, Amides and Esters). The specific objectives outlined in the SHS Chemistry teaching syllabus are:

a. Describe the nomenclature and isomerism of alkanes, alkenes, and alkynes

b. Write the names and structures of given alkanols, alkanoic acids, amides, and alkyl alkanoates (MOESS, 2008)

Organic chemistry as a component part of the SHS level chemistry is broad. It has many topics under it; it is only an integral part of the chemistry paper set by West Africa Examinations Council (WAEC) at the Senior Secondary School Certificate Examination (SSSCE) level. There are 2 chemistry papers at the SHS level. The chemistry paper one has two sections. In section A, students' are required to answer all the 60 objective questions, which have questions on organic chemistry. In section B, students' are required to answer five out of seven essay questions (which also include questions on organic chemistry). The chemistry paper two is a practical paper, which may or may not have questions on organic chemistry. The organic questions in the written section are not compulsory.

2.5 Students difficulties in writing IUPAC Names of Organic Compounds.

Clark (2000) pointed out that the ability of chemistry students to translate the IUPAC name of an organic compound into its structural formula is the most important as compared to the ability of chemistry students to give the IUPAC name of any given structural formula. In any chemistry examination, if a student finds it difficult to write the structural formula of any named compound, the candidate will find it difficult to understand what the examiner is asking for, hence, the performance of such a student is affected. (Clark, 2000).Study conducted by Hofstein, Bybee, and Legro (1992) showed that science students performance depends on so many factors, among these are the school environment, teaching and learning materials and equipment. Also, the type of school attended by the student also has an impact on his or her academic performance.

Lankford, Loeb &Wyckoff (2002) again asserted that, science teachers who teach in the less-endowed schools are inadequately prepared and can lack teaching experiences in the science subjects they teach. The less knowledgeable and less experienced science teachers are known to deliver less capable instruction. Through such lower standards, the overall performance of science students in science subjects can be affected. Chemistry at the microscopic and symbolic levels is highly difficult for science students (Ben-Zvi, Eylon, & Silberstein, 1988). This is because the microscopic and the symbolic levels of chemistry are invisible and abstract in nature, and hence learning of chemistry and understanding depends more on the use of the senses, hence chemistry students find it difficult in comprehending chemical equations, formulae, and symbols. The concept of IUPAC nomenclature of compounds is at the symbolic level and could be said to be difficult to most students. Chemistry students' understanding is hindered by the surface features of representations (Kozma & Russell, 1999). Most chemistry students see equations or formulae of chemical substances (for example, CH_3CH_2OH or C_2H_6O) as a combination of letters and number either than chemical formula. The difficulty of some students in understanding chemical representations is also observed in an area where most of the chemistry students are unable to make translations among formulae (Keig & Rubba, 1993).

2.6 IUPAC naming from the perspective of students in Ghana.

A study conducted by Baah's (2009) in Ghana revealed that chemistry students from well-endowed SHSs performed significantly better than chemistry students from less-endowed SHSs on naming of formulae of chemical compounds by the IUPAC nomenclature. High schools are classified as well-endowed and less-endowed institutions in most parts of the world. The classifications of the schools are based on the availability of certain facilities such as boarding or day facilities, libraries, and science laboratories. Again, the high school being single sex or mixed institution and the number of professionally qualified teachers in the school has great influence on their performance. In Ghana the classification has in one way or the other been influenced by the degree to which these facilities exist (WAEC, 2010b).

Again, on writing of chemical formulae of compounds using IUPAC names, Baah (2009) revealed that there is a significant difference in achievements between Chemistry students from Well-endowed and less-endowed schools, which is in favour of the students from the well-endowed schools. This indicates that chemistry students from less- endowed schools have problems with the IUPAC naming. According to the WAEC Chief Examiner's Report 2002, candidates showed weakness in IUPAC naming of simple organic compounds. This is confirmed by Hines (1990), who conducted a study with secondary school students in Botswana, pointing out that when it comes to writing chemical formulae from IUPAC names, science students have a greater challenge in doing so. Bello (1988) has revealed that the difficulties of students in solving stoichiometric problems are responsible for their inability to write chemical formulae as required by the IUPAC naming system.

(Adu-Gyamfi *et al.*, 2012) research work in Ghana identified the following challenges Chemistry students' face in naming organic compounds using the IUPAC naming system:

a. Students inability to identify multiple bond, use the right suffix for multiple bond or any other functional group, and use the right prefix for identical substituent or functional groups.

b. Students are not conversant with the root names of the number of carbon atoms in the longest chain.
c. Students count the carbon atoms of the alkyl substituent as part of the longest continuous carbon chain and that student assign positions to the carbon atoms in a particular chain without considering assigning the least position to any carbon atom that is directly bonded to any substituent or the functional group.
d. Inability to identify the chemical symbol or formula of any substituent or functional group, the correct position of and number of multiple bonds, functional, or substituent group(Adu-Gyamfi *et al*., 2012).

This shows that Ghanaian students have difficulties in the naming of organic compounds which has led to the failure of students to get the conceptual understanding and good academic performance in organic chemistry in general.

2.7 Model Sets in Science Classrooms

Models are very important in the teaching and learning of many scientific concepts. Scientific model makes up or contributes to scientific practice. It is a set of ideas that describes a natural process (Cartier, Rudolph, & Stewart, 2001). Models are experimental evidence constituted by empirical or theoretical objects and the processes in which they participate. They can be used to explain and predict natural phenomena (Cartier, Rudolph, & Stewart, 2001).The Use of models can be found in the use of billiard ball model of a gas, the Bohr model of the atom, the Gaussian-chain model of a polymer, the double helix model of deoxyribonucleic acid (DNA), agent-based and evolutionary models in the social sciences, and others (Frigg & Hartmann, 2006). Cartier, Rudolph, & Stewart (2001) suggested that curricula which include sets of molecular model representations provide students with opportunities to learn about the conceptual subject matter of particular disciplines and the nature of scientific knowledge. Frigg and Hartmann (2006) believes that philosophers acknowledge the importance of models with increasing attention and are probing the assorted roles that models play in scientific practice and in particular concept formation and development. Examples of science models include Probing models, phenomenological models, computational models, developmental models, explanatory models, impoverished models, testing models, idealised models, theoretical models, scale models, fantasy models, toy models, imaginary models, mathematical models, substitute models, analogue models and instrumental models. Gilbert (2005) specified the models' version of a phenomenon in the public domain in five modes of representation.

- The concrete mode is three-dimensional and made of resistant materials e.g. a plastic ball-and-stick model of an ion lattice.
- The verbal mode consist of a description of the entities and the relationships between them in a representation e.g. of the natures of the balls and sticks in a ball-and-stick representation, it also consist of an exploration of the metaphors and analogies on which the model is based e.g. covalent bonding.
- The symbolic mode consists of chemical symbols and formula, chemical equations and the mathematical expression e.g. the universal gas law.
- The visual mode makes use of graphs, diagram, and animations e.g. two-dimensional of chemical structure.
- The gesture mode makes use of movement by the body or its part.

Models are classified under Phenomenological models, Electron Density Models, representational models, Analogical models and Idealised models. Though many phenomenological models, fail to be obtained from a theory, it incorporates principles and laws associated with theories. Example of this model is the liquid drop model of the atomic nucleus, which portrays the nucleus as a liquid drop and describes it as having several properties. The Bohr model of the atom, the billiard ball model of a gas, the double helix model of DNA, the scale model of a bridge, the Mundell-Fleming model of an open economy, or the Lorenz model of the atmosphere are examples of models under representational model.

Examples of analogical models in science are the billiard ball model of a gas, the computer model of the mind or the liquid drop model of the nucleus. At the most basic level, two or more things are analogous if they share certain relevant similarities .These involve the use of computers to create models of a molecule using the electron density of the molecules. The electron models include slices, iso-density surfaces, and elpot models. They are constructed using standard algorithms contained in versions 3 and 4 of Spartan running on a Silicon Graphics Indigo workstation (Polkinghorne, 1989).

2.7.1 Molecular Model Sets in Chemistry

Models had played important role in science teaching and learning of Chemistry. It was introduced in chemistry teaching as early as 1811 by Dalton (Hardwicke, 1995). The ‘golden age’ of molecular models started with the production of many commercial molecular model sets based on Stuart`s space filling models in the 1930s.Since the introduction of models, different types of molecular models such as stereo-chemical projections, virtual computer models and traditional 3D models are widely used in chemistry education. The uses of these models have been proven to be useful in teaching many topics across the curriculum. The benefits of molecular models in science education in general is explained by the assumption that tangible materials such as structural models play very important roles by supporting students when connecting the different levels of concept representations (Ferk, Vrtačnik, Blejec, & Gril, 2003). From Plato's time, or even earlier, till today scientists in particular, visualised their ideas on the nature of matter by building concrete models. This field of study helped to make the study of certain concepts a reality. Today, new developments in science related to the application of molecular models and modelling techniques, computational methods, and computer graphics have contributed largely to resolving the structure of the nature of genes, important proteins, biologically active molecules found in drugs design, and development of new materials with unusual properties like self-organising molecules. The uses of concrete models, pictorial representations, animations and simulations have been shown to be beneficial to students' understanding of chemical concepts (Tasker & Dalton, 2006).

At higher levels students may need to work with electron density models and this becomes easy to understand when students are used to 3D molecular models which are easily applied to a broad range of topics which deal with especially structure of chemical substances. In addition, when students finally learn about orbital concepts they are better prepared because they already have a well-developed 3D picture of electronic structure to refer to. The type of models in use have widespread, precise application in chemical research (Bader, 1991), so students who understand and use 3D and electron density models find it easier progressing to more advanced theories on structure and naming of molecules. Molecular models help making predictions, guide inquiry, summarize data, justify outcomes and facilitate communication (Gilbert & Boulter, 1998). Scientists, engineers and science educators use models to concretize, simplify and clarify abstract concepts, as well as to develop and explain theories, phenomena and rules. An important value of molecular models in science and science education is their contribution to visualization of complex ideas, processes and systems. A virtue of a good molecular model is that it stimulates its creators and viewers to pose questions that take us beyond the original phenomenon to formulate hypotheses that can be examined experimentally (; Raghavan, & Glaser, 1995). Researchers underscored the need for molecular models as enablers of students' mental transformation from two-dimensional to three-dimensional representations (Dori & Barak, 1999).

In teaching science, models become vital if the visualization of entities within exemplar phenomena that take place (Gilbert, 2005). The development of models and representation of them are crucial in the production of meaningful knowledge. Molecular models can function as a bridge between the scientific theory and the world as experienced. They can act as simplified depictions for abstract theory and they can also be idealizations of a reality as imagined, based on the abstraction of a theory. Molecular models can also depict many different classes of entities, covering both macro- and micro- levels of representation. Cartier, Rudolph, & Stewart (2001) have expanded the concept and use of scientific models to include the set of ideas that may be used to describe a natural phenomenon: a scientific molecular model is a set of ideas that describes a natural process, models are constituted by empirical or theoretical objects and the processes in which they participate; molecular models can be used to explain and predict natural phenomena; models are consistently assessed on the basis of empirical and conceptual criteria. And molecular models are also useful as guides to future research.

2.7.2 Description of Molecular Model Sets

The molecular model sets used in this research was 'Orbit molecular building system – large size'. This set was to produce a 3D spatial arrangement of molecules. The atom models used in this study included; carbon, hydrogen, chlorine, bromine, iodine and oxygen atoms. All the models of the atoms have pointed projection(s) showing their valency or chemical bond(s) formed at a stable state. Carbon showed tetra valence, Oxygen bivalence, and the halogens are monovalence. Their conventional colours were black, red and white for carbon, oxygen and hydrogen respectively. In general the halogens use green colours. Others which were in the box but not used in this research included; nitrogen - blue, phosphorous - purple, sulphur – yellow. The set also have medium and long grey links which could be fitted to the projections on the modelled atoms as bonds to build specific molecules.

Figure 2.4: Shows Molecular Model Set

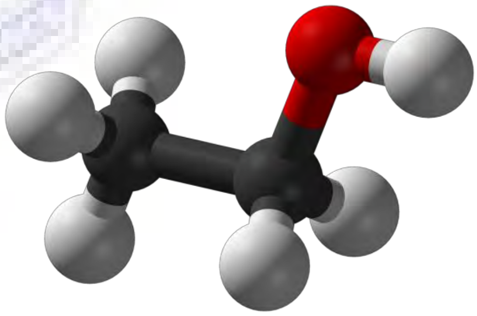

Figure 2.5: Shows Ethanol 3D balls

2.7.3 Challenges of Molecular Model Set

The use of concrete molecular models to demonstrate phenomena in chemistry teaching has been widespread for a relatively long time (Peterson, 1970). One of the problems that arise while using concrete models is that insufficient emphasis is placed on the fact that models are theory-based simulations of reality. The choice of model type has an impact on the image students create concerning the ways in which particles are shaped and how they function in the "real" world from a scientific viewpoint. Theoretical chemists, experimentalists and educators are taking advantage of computerized environment in order to stimulate different model types quickly and efficiently.

According to Hardwicke (1995), because no single model provides the total understanding to the structure and function of a molecule, each student's understanding is reliant on realising the limitations and strengths of each teaching model. Another importance factor is the teachers' level of understanding of models because some teachers have a simplified and limited understanding of models and modelling in science (Justi & Driel, 2005). However, Consistent use of molecular models would provide the needed skills and knowledge for both students and teachers in the writing of the structure and naming of organic compounds. Boo (1998), contends that, the extensive and accepted processes of using models have made the model appear as 'facts' to many teachers and students. Most of the times, students find it a problem in making differences between models and they do not regard models as different from the observed characteristic that the models explain. These critics do not make the use of molecular models sets ineffective but rather meant to guide teachers and learners to take steps to derive the maximum benefit from their use.

2.8 Pedagogical content knowledge (PCK) in Organic Chemistry

The success of any educational programme depends on the quality of those who teach it, this means that much attention should be attached to the production of high quality teachers (Pemida, 2005).It has been observed that one of the factors which accounts for students' poor performance and fear in chemistry is poor teaching methods (Njoku ,2005). The method of teaching could be regarded as the vehicle through which a message is delivered. Most of the time, the teachers' knowledge on the subject and the method employ normally known as pedagogical content knowledge is very essential in teaching and learning of science. The success of using molecular models in the IUPAC naming of organic compounds cannot be exempted from the teachers' prior content knowledge and methodology. From Bucat (2005), "PCK refers to knowledge about the teaching and learning of particular subject matter, taking into account the particular learning demands inherent in the subject matter". Pedagogical content knowledge was first proposed by Shulman (1987) and developed with colleagues in the Knowledge Growth in teaching project as a broader perspective model for understanding teaching and learning (Shulman & Grossman, 1988).

This project studied how novice teachers acquired new understandings of their content, and how these new understandings influenced their teaching. These researchers described pedagogical content knowledge as the knowledge formed by the synthesis of three knowledge bases: subject matter knowledge, pedagogical knowledge, and knowledge of context. Pedagogical content knowledge was unique to teachers and separated, for example, a science educator from a scientist. Along the same lines, Cochran, King and DeRuiter (1991) differentiated between a teacher and a content specialist in the following manner: Teachers differ from biologists, historians, writers, or educational researchers, not necessarily in the quality or quantity of their subject matter knowledge, but in how that knowledge is organized and used. For example, experienced science teachers' knowledge of science is structured from a teaching perspective and is used as a basis for helping students to understand specific concepts. A scientist's knowledge, on the other hand, is structured from a research perspective and is used as a basis for the construction of new knowledge in the field. Pedagogical content knowledge has also been viewed as a set of special attributes that help someone transfer the knowledge of content to others (Geddis, 1993). It included the "most useful forms of representation of these ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations-in a word, the ways of representing and formulating the subject that make it comprehensible to others" (Shulman, 1987).

Furthermore, Shulman (1987) stated that PCK included those special attributes a teacher possessed that helped him or her guide a student to understand content in a manner that was personally meaningful. Shulman (1987) wrote that PCK included "an understanding of how particular topics, problems, or issues are organized, presented, and adapted to the diverse interests and abilities of learners, and presented for instruction". Shulman also suggested that pedagogical content knowledge was the best knowledge base of teaching. The key to distinguishing the knowledge base of teaching lies at the intersection of content and pedagogy, in the capacity of a teacher to transform the content knowledge he or she possesses into forms that are pedagogically powerful and yet adaptive to the variations in ability and background presented by the students. Some research that has stemmed from the introduction of PCK has attempted to address the question of how pre-service teachers learn to teach subjects that they already know or are in the process of acquiring (Magnusson, Borko, &Krajcik, 1994; Marks, (1991); Grossman, 1990).

2.9 Teachers and Students Attitude towards Science

The definitions concerning attitude are distributed to a wide range of literature. Therefore, the attitude's definition is very difficult to summarize in one sentence. However, all definitions for the attitude are within a consensus in which they are positive or negative thoughts, feelings or behaviours towards the objects around us (Petty, 1995). The attitude is a psychological construct which has cognitive, affective and behavioural components. The cognitive component contains a set of beliefs about the attributes of the attitudes' object. The affective component includes feelings about object. The behavioural component consists of the way people act towards an object (Salta &Tzougraki, 2004).

This construct is an important predictor of the feelings, emotions or behaviours one person has toward an event or an object(Anderson, 1988) .The attitude is viewed as "a learned, positive, or negative feeling about science that serves as a summary of a wide variety of beliefs about science"). Therefore, the accurate acquisition of attitudes will be useful for improving the quality of teaching Organic Chemistry. The statements like "I like chemistry" or "I hate chemistry" indicate negative or positive feelings towards learning chemistry. That two students that have these different feelings are subjected to the same training will lead to different conclusions. Affective dimension acts as a bridge between the behavioural and the cognitive dimensions in learning. If the teacher is unable to build this bridge on her/his students, she would not perform an effective teaching. As well as cognitive factors, concerns, attitudes, affective factors and self-efficacy beliefs are extremely important in learning (Turner & Lindsay, 2003).

According to Siti Norliana (2008), attitude is the way students behave and think. However, the attitude is not static because attitudes can be changed depending on the individuals. Students who have bad attitude can change their attitude by identifying their problem. When the problem is identified, the attitude can be corrected. Oluwatelure and Oloruntegbe (2009) reported that ‘Attitude is a concept, which arises from the attempt to account for the observed regularities in the behaviour of individual persons, the quality of which is judged from the observed evaluative responses one tends to make’. An individual can show positive or negative attitude towards a particular object, subject or idea. In a classroom, teachers can identify attitude of students by observing their behaviour. Students who always complete their homework and ask question during chemistry class are said to show positives attitudes in learning chemistry.

Research has suggested that attitudes are linked with academic achievement (Salta &Tzougraki, 2004; Freedman 1997). Also, there is an agreement among educators on the importance of students’ attitudes toward science courses in school (Osborne, Simon, & Collins, 2003). However, there is not an agreement about how to evaluate the attitudes. As a developing nation, Ghana appreciates the importance of science education in her development and the teacher is vital in the education substratum. The quality of any educational program depends on the quality of those who teach and learn it. This underscores the importance that should be attached to the production of high quality teachers (Pemida, 2005).

The continuous records of students’ poor performance have attracted a lot of assertions (Nwagbo, 2002 and Njoku, 2005). Nwosu (2003) had pointed out that the teacher is an important determinant of the quantity of learning by the learner Eze and Njoku (2011) opined that teachers are the pivot of the education system and therefore they are at the centre of any reform effort in the system. According to Ikeobi (2010), it is the teacher who organizes the interactions between the subject (learner) and the object (learning materials). It is the teacher who ensures that equipment and materials are properly used by the learner to achieve the expected objectives. All these points to the fact that the teacher is a very significant factor when the learners failed to exhibit the expected mastery in a science subject like chemistry. Njoku (2007), research on factors that affect students' performance in practical chemistry listed among others teacher's attitude to chemistry laboratory work. Equally, Njoku (2007) attributed students descending differential achievement of chemistry students to three categories of quantitative analysis, qualitative and theory of practical questions to wrong way and manner teachers teach practical chemistry. Earlier studies on students' attitudes to learning and what pupils learn were found to be greatly influenced by how they are taught. Pupils will be unable to receive enough science learning experience when school teachers themselves are not pleased with science teaching. Teachers attitude have been cited by several studies as an important determinant in attitudes formation (Myers & Fouts, 1992, Piburn & Baker, 1993). A sample of 699 pupils from 27 high schools in America through a study conducted by Myers and Fouts (1992) established that, the most positive attitudes were associated with high level of involvement, very high level of personal support and strong relationships with the learner.

A review of Woolnough's work according to Osborne and Simon (2003), revealed six factors that were responsible for pupils choice or non-choice of the sciences. The two strongest factors were the influence of student's positive experience of extracurricular activities and the quality of the science teaching. It has also been identified that, all teachers in that particular work know that the teaching method or the pedagogy does indeed make a difference (Reiss, 2003, Osborn & Collins, 2001). Another factor important for students' acquisition of skills in science is students' attitudes and belief. Students always develop some sort of idea about what is all about, how scientists are as persons, what they actually do and how this relates to the society, the enrolment, their lives and other people. According to Alsop and Watts (2003), learning involves moving from the familiar to the unfamiliar, transferring the emotional quagmire of success, self-doubt and challenge as well as classroom identity.

Chemistry learning develops the scientific habits in students, which are transferable to other areas in life. Such habits involve non-reliance on superstition, use of critical thinking and respect for other people opinions. Deboer (1987) points out that students' achievement is influenced by favourable attitudes towards oneself as well as the subject. A student with positive self-concept of ability spends more time and energy in the subject thus gaining mastery of subject resulting in success. On the other hand, Deboer (1987) points out that students' achievement is influenced by favourable attitudes towards oneself (positive self-concept) as well as the subject. A student with positive self-concept of ability in a subject has a higher probability of developing favourable attitudes towards that subject, and as a result spends more time and energy in the subject thus gaining mastery of the subject resulting in success. Deboer (1987) further argues that as a result of this success, the student is reinforced further to continue performing well in the subject possibly developing stronger favourable attitudes, towards the subject, resulting in a vicious cycle. Mwamwenda (2004) argues that a person's self-concept is a guide to their personality in terms of his or her own feelings, attitudes, psychological health and the way he or she is likely to interact with others in and outside his or her environment.

Research has further shown that there is a positive correlation between attitudes and achievement; however, neither attitudes nor achievement is dependent on the other; rather they interact with each other in a complex and unpredictable way. Factors that influence students' attitudes towards a subject vary from one place to another. Furthermore, there are also other stronger predictor variables outside the school, which influence students' attitude towards a subject. These include parental influence and beliefs from ones culture (Muya, 2000), As such, the area pertaining to the attitudes towards sciences needs more research because the performance in Mathematics and Sciences is still low. This lends more weight to the study conducted by Garrahy (2001), on three third-grade teachers' gender-related beliefs and behaviours, who found out that teacher's attitudes towards the subject significantly, correlate with students' achievement. The students' attitudes regarding the interest of Chemistry course are also neutral .The content of Chemistry curriculum, the Chemistry lessons time, the methods of teaching Chemistry, and lack of laboratory experiments might be some of the reasons that form such attitudes. This is supported by Freedman (1997) who says that a positive attitude towards Science is related to the laboratory programme. Chemistry in most schools is taught theoretically without hands on activities and thus lack of practice decreases students' interest for Chemistry lessons.

Koch (2005) said that teachers' feelings and attitude about science can affect their students 'feelings and attitudes as well. Students reported to have positive experiences during their science class were said to be influence by their teachers' positive attitude towards science. It can be interpreted that when teachers are enthusiastic in teaching the science subjects, the students will also be enthusiastic towards the subjects. This is proven by a research done by Bauer (2002) that said, students' positive attitude was influence by the teachers' enthusiasm, effectiveness in teaching presentation on experiment. So, teachers' attitude towards the subject taught is important to the students' teaching and learning process. According to Ward *et al*. (2005), attitudes of students towards science are formed at an early age. At an early age, parents and teachers can observe the student attitude towards science. When the students show negative attitude in learning science, parents and teachers can take necessary actions to make the student have positive attitude towards science. It is easier to change the children's attitude rather than changing adolescents' attitude. Thus, good and positive input should be given to children at the very start of life. This is related to what (Pollard *et al*., 2000) found through their study. Students tend to have poor attitude in learning science at the primary school level. When the students grow older, it has been observed that science will become one of their least preferred subjects when compared to other subjects in the curriculum. This is an environmental challenge that science teachers are currently facing. The chemistry syllabus and content are other factors that contributed attitude to chemistry. The students dislike science because of the amount of information they have to learn as well as the amount of time spent for writing in science classes (Pollard *et al*., 2000; Ward et al., 2005).

According to Jegede (2007) and Domwonyi-otu and Avaa (2011), a lot of students said that chemistry is too broad for them to learn in a short time. Students find it a bit difficult to learn chemistry because of its cramped syllabus. A lot of chemistry teachers claimed that they have to make extra classes to cover all of the chapters in the syllabus. This issue is challenging to both students and teachers.

The teachers said that they do not have enough time to teach and make the students fully understand the concept of chemistry during the normal school time. Thus, extra time and energy have to be given to teach chemistry to the students. Students who really want to learn will have little problem grasping the concepts. However, weak students will find chemistry very dull and boring. In order to make students have more positive attitude in learning science, people around them, especially the teachers and parents, have to give opportunities and time to engage with the processes and the procedures of science (Pollard *et al*., 2000; Ward *et al*., 2005) Peers and other students can also influence the students' attitude in learning science subjects, thus chemistry. Other students' opinion on chemistry can affect students 'attitude in learning chemistry (Berg *et al*., 2003). This is because students are easily influenced by people of their own age. Other students' opinions on chemistry can affect students' attitude in learning chemistry (Berg *et al*., 2003).

If majority of the students in a school have bad attitude and opinions in chemistry, other students are likely to have the same reaction towards the subject. Most of the times, students complain about the course content. They complain that chemistry is too difficult and takes a lot of time to study because of the weight of information the subject has (Pollard *et al*, 2000; Ward *et al*., 2005). When a lot of students complain about the same thing, other students will have a negative attitude in their mind, which can influence their attitude towards learning chemistry.

The formation of students' positive attitude towards chemistry would require a lot of time and careful planning (Azman, 2003). Positive attitude towards learning chemistry cannot be formed over a short period of time. Therefore, the society at large, namely the education service, teachers and parents, have to link hands and ideas to overcome this environmental challenges of negative attitude toward learning chemistry. This is to ensure future communities that are balanced in scientific knowledge as well as technology, social, humanities and other subjects in this world for a better future ahead.

2.10 Factors Influencing Gender Performance in Science

Some of these factors are discussed below;

1. **Level of parent education**

Level of parent education also related to the expectations of girls in science. A 2006 study showed that parental education level was a predictor of science grades and activities of girls. The authors speculated that this might be due to "differential expectations" of more educated parents who expect boys to take science courses but allow girls more freedom to choose whether or not to take science courses (Simpkins, Davis-Kean, &Eccles, 2006).

Parents are not the only individuals that sway girls' beliefs in stereotypes. As girls get older, beliefs of their classmates are held in greater esteem than those of parents. During adolescence, gender stereotypes also become more pronounced socially. Girls not only have to deal with their own fears of science but also fears of rejection by peers if they do pursue science. This fear of social retaliation is related to belief in the stereotype of poor performance of girls in math and science. A study by Kessels (2005) reported that a sample of 8th and 9th grade children perceived students who liked physics as more masculine whereas students who liked music were perceived as more feminine. Boys were also reported to dislike students who went against sanctioned prototypes (e.g., girls who liked physics). The study also found that girls who liked physics felt unpopular with the boys. In a time when girls are dealing with the trials of puberty and social changes of moving to high school, such social repercussions could be significant in a girl's decision to pursue science classes.

A second symptom of the gender gap problems in science education is that girls lack science self-confidence, which translates to a loss of interest in science after junior high. One might think that this lack of confidence would come from lower achievement in the fields in question. This, however, is not the case as studies have shown that boys consistently produce higher ratings of science self-efficacy and self-concept even when their achievement scores are lower than or comparable to those of the girls. This low science self-confidence may, as girls grow older, translate into lack of interest in the sciences, which leads girls to drop out of science classes as soon as they are allowed.

One study demonstrated the tendency of girls to underestimate their abilities, signifying low self-confidence in relation to a science lab activity. Both boys' and girls' confidence levels increased as a result of a science lab activity. The respective levels of absolute level of confidence, however, were significantly lower for girls than for boys, both before and after the lab activity (Klahr, Triona, &Willaims, 2006). The most interesting part of this study was that while the girls and boys did not differ significantly in the amount of effort shown in the lab, the girls did not gain the same amount of confidence from a relatively similar amount of effort. This demonstrated that surmounting the initial lower confidence level of girls in relation to boys is not a matter of trying to increase the effort put forth by girls, rather that the solution must come by increasing the overall initial confidence level.

2. **Low self-confidence of girls**

A second study investigating the unreasonably low science self-confidence of girls, even when their achievement scores were higher, produced particularly startling results. Although the girls in the sample for this study had higher science grades, they still only maintained equal self-confidence with the boys. Despite their higher grades, girls reported higher levels of science-related anxiety and physiological stress but lower levels of mastery experiences (Britner & Pajares, 2006). This is disturbing because it shows that even when they are performing at the same or higher levels than their male peers, girls are still less confident in their abilities. This suggests some underlying problem with the perception of the subject as a whole. Often, these low levels of science self-confidence seem to translate, as girls get older, to a lack of interest in the sciences altogether. Not only do girls begin to shy away from science but they also begin to drop out of science classes as they progress through school (Stake, 2006).

In addition, they also tend to lose interest in science outside of the classroom. A recent study focusing on submissions of questions to a science website showed that although girls contributed many of the questions in the sample, the number of questions asked by girls decreased significantly when they entered high school (Tsabari, Sethi, Bry, &Yarden, 2006). This demonstrated that not only does their fear of doing badly affect girls' choice of classes but also decreases their overall interest in science, even outside of the classroom.

3. The way science is presented in the classroom

Girls' dissatisfaction with the way in which science is presented was also shown in a 2002 study in which girls expressed their thoughts on this subject to teachers. The study showed that girls want connections to science but have a hard time relating what they do in science classes to the world around them. According to Buck (2002), teachers interpreted girls' requests by trying to help them understand the applications of science education. Solutions included use of current events, more projects and games, and relation of topics to daily lives. This, together with the previously mentioned studies, suggested that girls are drawn to natural and biological sciences because they can be related to the real world. Therefore, the solution to decrease the levels of dissatisfaction of girls in other areas of science may be to make an effort to relate concepts of other sciences to real life.

Girls have been shown to have very specific interests within the field of science (such as biology), yet these are the subjects that students are tested on least often. This trend of girls' interests pointing toward natural and biological sciences was also supported by the previously discussed study addressing questions to a science website (Tsabari et al., 2006); girls ask more questions relating to the natural sciences. The results of such studies make it questionable whether girls are actually performing worse on standardized science tests because they have lower ability levels or if gender differences only reflect a bias in question selection toward the hard sciences.

Because girls are dissatisfied with the way science is presented, alternative educational methods might be helpful in changing this perspective. For example, some studies have suggested a mono educational system (rather than coeducational) as a treatment that may benefit girls as well as boys due to different learning styles and interests (Haussler & Hoffmann, 2002), thereby increasing satisfaction with the way science is presented to students

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter deals with the method and procedure that was used in the research. It involves research design, population, sample and sampling procedures, and research instrument for data collection, validity and reliability of the instrument, data collection as well as data analysis procedure.

3.1 Research Design

The research is an experimental design. Amedahe (2002) explained that the design is potentially useful in that it controls all threats to validity and all sources of bias such as history and maturation. In this type of design, two groups were formed; an experimental group and control group. A pre-test was administered by the researcher to measure the performance of the students with regards to initial knowledge on the topic. After the pre-test, the experimental group was taught using molecular model set while the control group was taught using traditional method of teaching. For the first week, a pre-test was conducted and the groups were taken through the following; meaning of organic compounds ,differences between organic and inorganic compounds, substituent's and functional groups .The remaining six weeks were used for naming of Alkanes, Alkenes, Alkanols, Alkanoic acids and alkyl alkanoates. At the end of the teaching period both groups were given the same test items (post-test) to measure their performance based on the teaching learning outcomes. The purpose of the post-test was to evaluate the achievements of the two groups in the learning of IUPAC naming of Organic Compounds.

3.2 Study Area

Effiduase Senior High School is located in Effiduase Ashanti, 2 kilometres to the South western part of the town.The town is found in the Sekyere East district in Ashanti region and it is the district capital. The district is bounded to the south by Ejisu Juaben Municipal, to the East by the Kwaso district: to the North by Sekyere Kumawu district and to the West, Sekyere South district.

3.2.1 Population

A population is defined as all elements (individuals, objects and events) that meet the sample criteria for inclusion in a study (Burns & Grove, 1999).The target population for the study was all science students in Effiduase Senior High School in the Sekyere East district of the Ashanti Region, but the accessible population was form 3 SHS students. This school was chosen for the study because the researcher is more familiar with the area and students in the school.

3.2.2 Sample and Sampling Procedures

The term sampling, as used in research, refers to the process of selecting the individuals who will participate (e.g., be observed or questioned) in a research study. A sample is any part of a population of individuals on whom information is obtained. It may, for a variety of reasons, be different from the sample originally selected. (Fraenkel & Wallen, 2009).Two form three science classes were purposively selected for this study because

- they have been introduced to topics in IUPAC naming of organic compounds.
- the two classes were offering elective chemistry as a subject
- the classes had the same number of students

Simple random sample was used to put the two classes into the two groups (Experimental and Control groups). The method of selecting the students into the two groups was such that, two cards, on which the names of the two groups were written were put in a bowl. The class prefect of each class was called to choose randomly any of the cards without looking at what was on the card. This sampling technique gave all members in the target group equal chances to be picked (Bell, 1999). The sample represented the participants the researcher used because they have similar characteristics as the accessible population. The reason for using sampling is also in line with Sarantakos' (1998) finding that sample is noted to produce comparable and equally valid results. Sarantakos (1998) further explained that sample offers more detailed information and high degree of accuracy because they deal with relatively small numbers of units.

Table 3.1: Class and Sample Size

Class	No. of students	No. of females	No. of males
Science one (Control)	41	14	27
Science two (Experimental)	41	18	23

3.3 Research Instruments

Tests (pre- and post-test) and questionnaire were used as the main instruments for collection of data for the study.

3.3.1 Test

The test items for the pre and post tests were thirty (30) questions. Most of the questions were selected from essay questions set by WAEC for the past six years (2008-2013).Similar sample questions were also developed by the researcher. The test items consisted of giving IUPAC names, writing condense formula and drawing of structural formulae for compounds. Included in the tests were twenty (20) items on naming, five (5) on writing condensed formulae, and five (5) on structural formula, A it was marked and scored for 50 marks.

3.3.2 Questionnaire

Creswell (2005) further described questionnaire as a form used in survey design that participants in a study complete and return. It is a mechanism from which information is gathered by a researcher, asking questions to respondents on a topic being researched. On the questionnaire, the students' opinions and attitudes towards naming of organic compounds in teaching and learning were assessed to determine any attitudinal changes due to the new instructional approach. The questionnaire on students' attitudinal change was categorized into *Pre* and *Post*. *Pre* refers to students' attitude towards IUPAC naming of organic compounds before the instructional approach, and *Post* was their attitude towards systematic naming of organic compounds teaching after the instructional approach. The Students' Attitudes Questionnaire (SAQ) used for this study was adapted from Martin-Dunlop and Frazer (2008) and modified to suite the study.

3.4 Validity

According to Joppe (2000), validity determines whether the research instrument truly measures what it was intended to measure. The test items prepared on the bases of the selected topics were shown to some experience chemistry teachers in two Senior High Schools and the researcher's supervisor of this work for necessary suggestions to ensure its contents are valid. The draft questionnaires were also shown to the researcher's supervisor and some chemistry teachers for scrutiny and based on their suggestions; the questions were modified to achieve the purpose of the study.

3.4.1 Reliability

The majority of the objectives and essay questions were selected from WAEC past questions (2008-2013). This was to ensure that their appropriateness measures to the WAEC standard on IUPAC naming of organic compounds. This approach is supported by Kirk and Millar (1999), the extent to which a test or procedure gives similar results under constant conditions on all occasions. The reliability of the test item was 0.67 using Cronbach Alpha. This shows that the test item was reliable.

3.5 Data collection procedure

With the letter of introduction from Head of Science Education Department of the University of Education, Winneba, permission was sought from the Head of science Department of Effiduase SHS for the administration of the research instruments. On the first visit to the school, I sought permission from the Head of Science Department to work with the science students that form the sample and informed them about the purpose of the study and the process of administering the instruments.

3.5.1 Test

A pre-test was conducted for the two groups on their first meeting with the researcher. The answer sheets were collected after 60 minutes of working. They were marked and the marks recorded. The two groups were taken through the following for six weeks; meaning of organic compounds, differences between organic and inorganic compounds, substituents and functional groups. Also the naming of Alkanes, Alkenes, Alkanols, Alkanoic acids and alkyl alkanoates and at the end of the teaching period both groups were given the same test items (post-test) to measure their performance based on the teaching- learning outcomes. The answer sheets were collected after 60 minutes and they were marked and the results recorded.

3.5.2 Questionnaire

The purpose of the study was explained to the respondents and their consent was sought verbally. They were assured of anonymity and confidentiality. The research instruments were administered by the researcher personally .This was to enable the researcher to ensure that the questionnaire got to the respondents directly .It was also to explain further any part of the questionnaire that posed a problem to the respondents.

3.6 Data Analysis

The data collected from the study were edited, collected and analysed as mentioned by Blaxter, Dodd and Tight (1996). The items in the test was marked, scored and fed into a computer for analysis. The Statistical Package for Social Science (SPSS) version 16 for windows 2007 was used for the analysis. This is because it provides among other things, a variety of ways to summarize the data and accurately describe variables of interest (Easterby-Smith, Thorpe & Lowe, 1991). The independent-sample t-test was used to find out whether or not there was significant statistical difference between the two methods of teaching.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0 Overview

This chapter presents answers to the research questions on performance, difficulties and some factors that accounts for the SHS Chemistry students' difficulty in naming and writing structural formulae of organic compounds using the molecular model set.

4.1 Analysis of Data

The data generated from students tests (pre- and post-tests) were analysed to reflect research questions. Detailed discussion has been made on the findings in the subsequent part supported with related literature.

4.1.1 Analysis with respect to Research Question One

RQ 1: To what extent does the use of molecular model set teaching strategy improve the academic performance of students in Effiduase Senior High School?

The first question raised in this study was to find out the extent to which the use of molecular model set affects the academic performance of students. As indicated in chapter three, students were put into control and experimental groups where the control group were exposed to the normal traditional teaching method whiles the experimental group experienced molecular model teaching approach. All the students in these groups were given pre- and post-test to check their general knowledge and the effect of each teaching strategy on students' academic performance. Students' mean scores in pre- and post-tests were used to compare their performance.

Table 4.1: Mean scores of students in pre and post tests

Serial no	Control Group		Experimental Group	
N =41	**Pre-test**	**Post-test**	**Pre-test**	**Post-test**
1.	23	27	27	40
2.	24	25	24	35
3.	23	29	26	38
4.	28	28	31	45
5.	26	27	29	37
6.	24	25	28	43
7.	29	30	24	38
8.	24	25	22	34
9.	26	24	22	32
10.	24	26	24	36
11.	25	29	30	41
12.	32	35	26	39
13.	27	28	27	41
14.	29	31	22	33
15.	28	25	32	46
16.	22	25	27	38
17.	28	26	26	36
18.	27	29	24	36
19.	26	30	24	37
20.	28	28	28	41
21.	29	27	28	44
22.	27	28	28	40
23.	22	26	29	42
24.	24	28	27	38
25.	26	27	26	37
26.	25	28	25	30
27.	31	33	22	33
28.	22	26	22	32
29.	22	23	24	35
30.	23	25	25	30
31	25	26	23	32
32.	24	26	23	31
33.	22	24	23	31
34.	23	27	22	29
35.	23	25	24	32
36.	23	26	24	31
37.	24	28	22	30
38.	26	27	23	33
39.	27	23	26	35
40.	25	28	24	32
41.	23	29	23	34
Statistics				
Min	**22**	**23**	**22**	**29**
Max	**32**	**35**	**32**	**46**
Mean	**25.34**	**27.12**	**25.27**	**36.02**
Median	**25**	**27**	**24**	**36**
SD	**2.57**	**2.46**	**2.68**	**4.51**

*SD=Standard deviation.

From Table 4.1, the marks obtained by student in the pre-test of the control group ranged from minimum of 22 to maximum of 32 with a mean of 25.34 and a standard standard deviation of 2.57, while the experimental group ranged from minimum of 22 to maximum of 32 with a mean of 25.27 and a standard deviation of 2.68. This means that about 50% of the students had marks below the minimum pass mark of 25. The results showed that students' performance was almost the same in both control and experimental group in the pre- test, which means students could not get the concept of naming organic compounds hence their poor performance. The post- test of the control group ranged from minimum of 23 to maximum of 35 with a mean of 27.12 and a standard deviation of 2.46 while the experimental group ranged from minimum of 29 to maximum of 46 with mean of 36.02 and a standard deviation of 4.51.This means none of the student had marks below the minimum pass mark of 25. This shows a gap between the two groups, meaning that there was an effect on the academic performance of the students in the experimental group who were exposed to molecular model set instructional approach compared to control group who experienced the normal traditional instructional approach in teaching .The use of science models such as concrete models ,pictorial representations, animations and simulations in science education have been shown by many researchers to be beneficial to students ' understanding of chemical concepts.(Tasker & Dalton ,2000; Ferk, Vrtacnik, Blejec ,& Gril,2003).

4.1.2 Testing of Hypothesis with respect to Research Question One

It was hypothesised that:

H_o: There is no significant difference in academic performance of students in Effiduase Senior High School using molecular model set teaching strategy and traditional method in naming organic compounds.

To confirm the difference in academic performance, an independent sample t-test was used to analyse the scores from both the pre-and post-test.

Table 4.2: Results of Independent-sample t-test Analysis

	F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference
PRE-TEST	0.050	0.823	0.042	80	0.966	0.024
POST-TEST	16.875	0.000	-11.087	80	0.000	-8.902

Significant at 0.05, p<0.05, F= f -ratio,* t= t-test,*Df= degree of freedom,

The independent-sample t-test shown in table 4.2 indicates the difference in performance in students' pre and post-tests .In the pre-test of the control and experimental group the p-value gave 0.823>0.05 (Mean difference=0.024) meaning that there was no significant difference in the pre-test of both control and experimental group. In the post-test, the p-value (0.000< 0.05) (Mean difference =8.902), meaning there was a significant difference in the post-test between the control and experimental group after the introduction of the interventions (traditional instructional approach for the control group and molecular model set instructional approach for the experimental group). The hypothesis (*H_o1***)** was not valid hence was rejected. This means that the introduction of molecular model instructional approach improve the academic performance of the students.

4.1.3 Analysis with respect to Research Question Two

RQ 2: To what extent will gender influence the academic performance of the students in naming organic compounds after they are taught using molecular model set in Effiduase Senior High School?

The research question two was set to seek if any; the introduction of molecular model set instruction approach will have an effect on the academic performance of males and females selected for this study.

Table 4.3: Mean Scores with respect to Gender

	Gender	N	Mean	Std. Deviation	Std. Error Mean
PRE-TEST	Male	50	26.30	2.697	.381
	Female	32	23.81	1.512	.267
POST-TEST	Male	50	32.82	6.381	.902
	Female	32	29.62	3.966	.701

* N = Number of Students * Std. Deviation = Standard Deviation *Std. Error Mean = Standard Mean Error

Table 4.3 shows the mean scores of both male and female students' academic performance selected for this study. In the pre-test, the mean scores of the males gave 26.30 (SD=2.697) and that of the females gave 23.81 (1.512). This means that although the general performance of the students was not better, the males performed better in the pre-test than the female students. From Table 4.3 the mean scores of the male students (32.82, SD=6.381) were better than the mean scores of the female students (29.62, SD=3.966) in the post-test. This also actually means that the males students performed better even after the introduction of the interventions.

An independent sample t-test analyses was conducted to check the statistical difference in performance between the male and female students in the study.

Table 4.4: Independent-sample t-test of Mean Scores in Gender

	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
PRE-TEST	11.734	.001	4.754	80	.000	2.488	.523
POST-TEST	15.125	.000	2.533	80	.013	3.195	1.261

*Significant at 0.05, p<0.05

Table 4.4 gives more explanation on what Table 4.3 explained. From Table 4.4, the p-value in the pre-test gave 0.001 (Mean=2.488), this means that there was a significant difference in the mean scores between the male and female students although the general performance in the pre-test was not encouraging. The post-test from Table 4.4 gave a p-value of 0.000 (Mean=3.195) implying that there was statistically significant difference between the mean scores of male and female students selected for this study. The result is in line with the study conducted by (Klahr, Triona, &Willaims, 2006). Both boys' and girls' confidence levels increased as a result of a science laboratory activity. The respective levels of absolute level of confidence, however, were significantly lower for girls than for boys, both before and after the laboratory activity.

4.1.4 Analysis with respect to Research Question Three

RQ 3: What influence does the use of molecular model set have on the performance of students in Effiduase Senior High School towards the naming of organic compounds?

The research question three sought to find out the attitude of students before and after the interventions were introduced to the various groups. Students were made to answer questionnaire which focused on their attitudes towards the study of organic chemistry (naming of organic compounds) developed and modified from (Martin Dunlop & Fraser, 2008). *Pre*- and *Post*-questionnaires on students' attitudes towards the learning of organic chemistry (naming of organic compounds) were given to the students to answer before and after the interventions.

Table 4.5: Mean Values of Pre- and Post-responses on their Attitude towards the study of systematic naming of organic compounds (Experimental Group)

		N	Mean	Sig.	Std. deviation
Students' Attitudes towards naming	Pre	41	3.03	0.00	0.43
of organic compounds.	Post	41	4.62		

*p<0.05 significance (α=0.05)

Table 4.6: Mean Values of Pre- and Post-responses on their Attitude towards the study of systematic naming of organic compounds (Control Group)

		N	Mean	Sig.	Std. deviation
Students' Attitudes towards	Pre	41	3.08	.061	1.24
naming of organic compound	Post	41	3.10		

*p<0.05 significance (α=0.05)

In Table 4.5, the students' mean values of pre- and post-responses on attitudes towards the study of systematic naming of organic compounds were compared. The mean scores (3.03) of the students' pre-intervention responses of the questionnaire were lower than their mean scores (4.62) after the introduction of molecular model set has been used for the same category of items in the experimental group.

In Table 4.6 for the control group, the mean scores (3.08) before the intervention (traditional teaching) were almost the same as after the intervention (3.10). To determine whether there were differences, pre- and post-intervention responses were statistically significant, a paired sample t-test analysis was used. The results confirmed that the differences in the pre- and post-intervention responses were statistically significant in the experimental group than the control group. The experimental group had a p-value of 0.000(α=0.05) meaning there is a significant difference in students' attitude towards the teaching and learning of systematic naming of organic compounds when molecular model set teaching strategy was used. The control group had a p-value of 0.061(α=0.05) meaning there was no significant difference in their attitude in teaching and learning of IUPAC naming of organic compounds when traditional method of teaching was used on them. Thus, the students' interests and attitudes towards the teaching and learning of IUPAC naming of organic compounds, and their learning environment significantly improved after their exposure to molecular model set teaching strategy than the tradition teaching strategy.

4.2 Discussion of Results

With respect to research question one, the SHS students in the experimental group exhibited higher achievement (Mean=36.02) than their counterparts in the control group (27.12) in students post-tests. Thus the SHS students taught with molecular model set method achieved better performance than the SHS students taught with only the traditional lecture method. The result has established that teaching methods were significant factors on students' achievement in naming organic compounds according to the research question one. The higher performance by the students may be as a result of the molecular model set aids that provided more concrete representations of ideas and concepts which were normally taught in abstract form in the regular organic chemistry classes. The result of the study is in line with other studies. By (Dori & Barak, 2001). Their work had a significant improvement in experimental students' academic performance because of their increased exposure to physical models and the active learning process these students were engaged in. While the experimental students were taught using molecular model types, the students were able to mentally construct multiple representation models for the same molecule. Teachers in the control group used traditional teaching, limiting students' experience to be partially or completely inadequate. These results are in accordance with the finding of Barnea & Dori (2000).

With research question two where the study sought to find if the performance of male and female students were affected and if there was a significant difference between the performances of both genders. Students' academic performance in the pre-test was not encouraging but the male students with (Mean=26.30) performed better in the pre-tests than the female students (Mean=23.81) for both experimental and control group. In the post-tests students' performance were high compared to the pre-tests and the argument stayed the same that the male students (Mean=32.82) performed better than the female students (Mean=29.62) for both experimental and control groups. This result is in line with Obumnenye and Ahiakwo (2013). In their study, it was revealed that experimental boys and girls were significantly better than control boys and girls in naming organic compounds. Mean difference between the performance of the boys and that of the girls in the experimental group was not significant. Again, the use of molecular model set in teaching nomenclature of organic compound proved very useful in learning the names and structure of organic molecules.

In research question three, students' attitudes towards the learning and teaching of IUPAC naming of organic compounds was analysed thus, before and after the introduction of the interventions in both experimental and control group. The results showed that students had more interest in the teaching and learning of IUPAC naming of organic compounds after the introduction of molecular model set in the teaching and learning processes in the study for the experimental group. Before the intervention, students attitude mean score was lower (Mean difference =3.03) than after the intervention (4.62). This showed that students in the experimental group were really affected by the use of molecular model set in the teaching of organic chemistry compared to the control group who were exposed to the ordinary traditional method of teaching. The results in the research question three agrees with that of Harrison and Treagust's (1996). Students had a strong preference to select the space-filling molecular model as a better representation of a molecule which increased exponentially positive attitudes of students towards the study of organic compounds.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Overview

This chapter focuses on the summary of the findings, conclusion and recommendations based on the findings of the study.

5.1 Summary of the study

This research was primarily designed to help improve students' academic performance in naming organic compounds using molecular model set in Effiduase Senior High School in the Sekyere East district of the Ashanti Region. An experimental design was used for this study. In this design the researcher used a questionnaire to solicit information on students' academic performance and their attitude towards the learning of IUPAC naming of organic compounds. An independent-sample t-test analysis was used to analyse the scores from the tests thus the pre and post-intervention test to show the impact of molecular model set teaching strategy on students' academic performance. The mean value of the pre-intervention test was 25.3 (SD=2.659) and that of the post-intervention test was 36.02 (SD=4.51) meaning that there was an improvement in the academic performance of the students for the experimental group. In the independent-sample T-test, the p-value gave 0.000 (were α=0.05), meaning that there was a significant difference in academic performance between the students in the experimental group (students who were exposed to molecular model set of teaching) and that of the control group (students who experienced traditional method of teaching). The performance of gender was also checked and the results from this study showed that in both the pre-and post-tests for both experimental and control group, the male students performed better in all aspect of the tests. The independent sample t-test analysis gave a p-value of 0.000 (α=0.05) showing that there was statistically significant difference between the mean scores of the male students and the mean scores of the female students. Student's attitude towards the study of naming of organic compounds was also addressed and after the intervention in the experimental group, students' attitude was changed compared to before the intervention when they felt learning IUPAC naming of organic compounds was difficult. It was concluded that the use of molecular model set teaching approaches should be integrated into teaching of challenging chemistry concepts at the senior high school level in Ghana.

5.2 Conclusions

Findings of this research indicate that, molecular model set provided an equal support for every student to eventually achieve an enhanced conceptual understanding of the concept. Through the teaching activities, it was revealed that students' performance was improved due to intense student-student interactions, peer support, active participation of all students in the lessons, maximum teacher support and increased teacher-student interaction. The study revealed that the students introduced to molecular model sets teaching strategy enjoyed the lesson and participated actively in the lessons, this resulted from the practical nature of the teaching approach. Since the lesson was activity oriented, students learn collaboratively and it provided opportunity for them to interact and discuss with their colleagues intensively.

The results of the study indicate that molecular model sets are most effective teaching approach than other teaching approaches. Further in the study, it was found that integration of molecular model sets in teaching organic chemistry topics help students to understand the process of solving organic chemistry problems and avoid misconceptions.

It can also be deduce from the study that, when the appropriate teaching and learning materials (TLMs) and methods are used, learners discover things on their own.

5.3 Recommendation

The following guidelines are recommended to schools and teachers who would like to include molecular model sets in the teaching and learning of Chemistry.

- Teachers are also advised to use varied methods of teaching that would satisfy individual ability and also make provisions for regular class exercises, project/group work, educational trips and other practical activities to make the study of organic chemistry more real, interesting and meaningful to students.
- Teachers should ensure that students are made more responsible for their own learning through group activities and discussions, sharing of ideas and cooperating with peers with some guidance from the teacher. This implies that chemistry teachers should model their instructions to enforce student-student interactions. For instance, using molecular model sets packages that will enhance group discussions or active learning among students.
- A common problem with many students in Senior High Schools is their laziness towards learning especially in the Science subjects. This study revealed that one effective measure teachers could use to nip this attitude of students in the bud is to adapt the use of molecular model sets in appropriate lesson, this would make them prepare adequately before coming to class. Also, students' participation in the teaching and learning process and teachers' support could make students adapt positive attitudes towards chemistry teaching and learning and therefore maximize their performance.

- Curriculum planners and developers, all stake holders associated with Science Education in Ghana should introduce more effective and innovative methods of teaching that will help students quit rote learning in favour of meaningful learning. This would motivate the chemistry students to develop positive attitude towards the subject.
- The Curriculum Research Development Division (CRDD) should ensure that the syllabus is not loaded so that teachers would not concentrate on the theory aspect alone but would also include a lot of practical lessons.
- More science laboratories should be built and well equipped and the school time table should be structured in a way that would ensure effective teaching and learning of chemistry lessons as well as other subjects.
- The Ghana Education Service (GES) should also make adequate provisions for training programmes such as seminars and other workshops for science teachers so that they can teach effectively in the classroom.

REFERENCES

Addison, P. &Wesley, B. (2004). *Understanding organic chemistry*. (4th ed) New York: Academic Press p 324-326.

Adu-Gyamfi, K., Ampiah, J.G., &Appiah, J.Y. (2012).Senior high school students' difficulties in writing structural formulae of organic compounds from IUPAC names. *Journal of Science and Mathematics Education, 6*(1), 175-191

Alsop, S, & Amp; Walt , M. (2003). Science education and effect. *International Journal of science, education. 25* (9), 1043-1047

Amedahe, F. K. (2002). *Introduction to educational research.* Cape Coast: University of Cape Coast.

Anderson, L. W. (1988). *Attitudes and their measurement. Educational Research, Methodology and Measurement,* An International Hanbook, Ed. John, P Keves,(p 421-426) New York: Pergamon Press,.

Azman, J. (2003). Sikappelajarterhadapfizik di sekolahkawasanfelda.*Journal Penyelidikan MPSAH, 7*, (2)19-27.

Baah, R. (2009). *Senior secondary school students' understanding of chemical formulae and chemical equations*. Unpublished master's thesis, University of Cape Coast, Cape Coast

Bader, R. F. W. (1991).*Atoms in molecules: A quantum theory.* (p 28-30) Clarendon: Oxford University press.

Barnea, N., & Dori, Y.J. (2000).Computerized molecular model in the new technology for enhancing model perception among chemistry educators and learners. *Chemistry Education: Research and Practice in Europe, 1*, 1, *10.* http://www.uoi.gr/conf_sem/cerapie/pdf/16barneaf.pdf.

Bauer, C. F. (2002). What students think: College students describe their high school chemistry class. *Science Teacher, 69*, (3) 52-55

Bell, J. W. (1999). *Doing your research project; A Guide for first-time Researchers in Education and Social Science* (3 Ed), (p14-18) London. Sage Publication.

Bello, O. O. (1988*).* Analysis of students' error in stoichiometric problems.*Nigerian Education Forum, 11*(2), 181-186.

Ben-Zvi, R., B. Eylon, and J. Silbestein.(1988). Theories, principles and laws. *Education in chemistry, May, 25* (3), 89-92.

Berg, C., Bergendahl, V., Lundberg, B. & Tibell, L. (2003). Benefiting from an open-ended experiment? A comparison of attitudes to, and outcomes of, an expository versus an open-inquiry- version of the same experiment.*International Journal of Science Education, 25*,(2)351-372.

Blaxter, L., Dodd, K. & Tight, M. (1996).*How to research. Buckingham:* Open University Press .p499-502.

Boo, H. K. (1998). Students' understandings of chemical bonds and the energetic

of chemical reactions, *Journal of Research in Science Teaching, 35*,(3) 569-581.

Britner, S. L., & Pajares, F. (2006). Sources of science self-efficacy beliefs of middle school students. *Journal of Research in Science Teaching*, *43*, (1)485-499.

Brooks, J. G. & Brooks, M. G. (1999).*In search of understanding: The case for constructivist classroom.* Alexanderia: Association for Supervision and Curriculum Development p153-157.

Brown, W, H., & Foote, C. S. (2002).*Organic chemistry (3rd*ed.). Singapore: Thompson learning Inc. p 97-101.

Bucat, R. (2005). Implications of Chemistry education research for practice: Pedagogical content knowledge as a way forward. *Chemical Education International, 6*(1), 1-3.

Buck, G. A. (2002). Teaching discourses: Science teachers' responses to the voices of adolescent's girls. *Learning Environments Research. 5*,(1) 29-50.

Burns, N. & Grove, S. K. (1999).*The practice of nursing research conduct, critique & utilization (2nd)*, Philadelphia: W.B .Sounders.

Cartier, J., J. Rudolph, and J. Stewart. (2001). *NCISLA, Wisconsin Center for Education Research. Wisconsin:* University of Wisconsin–Madison.

Chieu, M.H. (2005*). A National Survey of Students Conception in Chemistry in Chemistry. In Taiwan Chemistry Education Reg. Practice DOI: 1-.1-39 B901456J. Retrieved on 10 December, 2011 from: http.//pubs.rsc.org.*

Clark, J. (2000). *The names of organic compounds.Retrieved October 14, 2010, from http://www.chemguide.co.uk/basicorg/conventions/names.*

Cochran, K. F., King, R. A., & DeRuite+r, J. A. (1991).*Pedagogical Content Knowledge: A Tentative Model for Teacher Preparation*. East Lansing, MI: National Center for Research on Teacher Learning. (ERIC Document Reproduction Service No. ED340683)

Coll,R.K. (2004), *Investigating First Year Chemistry Learning Difficulties in South Pacific. Retrieved in June 10, 2014 from: http www.Wisegeek.co / what-is-organic chemistry.htm*

Cresswell, J.S. (2005) *Education Research, Planning Conducting and Evaluating quantitative research*. (P62-70) Upper Saddle River, J.J: Merrill. .

Daintith, J. (1981*). Dictionary of Chemistry*. London: Intercontinental book productions limited: p36-41.

Daley, R. F., & Daley, S. J. (2005).*Organic chemistry. Retrieved May 4, 2010, from the website*: www.ochem4free.com.

Danmaigoro, A.(2005).Language, need for Teaching science in Nigeria. *Journal of Science Education Research (NIJORSER). 1*(2) 36-39.

Davis, B., & Sumara, D. (2002). Constructivist discourses and the field of education: Problems and possibilities. *Educational Theory, 52*(4), 409-428.

Deboer, G.E. (1987). Predicting continued participation in college Chemistry for men and women. *Journal of research in science Teaching, 24*(6):52-238

Dirks, A. L. (1998*).Constructivist pedagogy, critical thinking, and the role of authority.Retrieved August 31, 2014, from http://webhost.bridgew.edu/adirks/ald/papers/constr.htm*

Domwonyi-otu, L. &Avaa, A. (2011). The challenge of effective teaching of chemistry: A case study. *Leonardo Electronic Journal of Practices and Technologies, 10*(18), 1-8.

Dori, Y. J., & Barak, M. (2001). Virtual and physical molecular modelling: Fostering model perception and spatial understanding. *Educational Technology and Society*, *4*(1), 61-74. The Falmer Press.

Dori, Y.J., & Barak, M. (1999).).*Computerized molecular model as a collaborative learning environment. Computer Supported Collaborative Learning - CSCL99 (pp. 142-150Stanford University, Palo Alto, CA, USAhttp://kn.cilt.org/cscl99/A16/A16.HTM*

Dougiamas, M. (1998).*A Journey into constructivism Retrieved October 20, 2014. From http://www.dougiamas.com/writing/constructivism.html*

Driver, R., Asoko, H., Leach, J., Mortimer, EF., & Scott, P. (1994*).*Constructing scientific knowledge in the classroom. *Educational Researcher, 23*, (7), 5-12

Easterby-Smith, M., Thorpe, R. & Lowe, A. (1991).*Management research: an introduction,* pp.231-234. London: Sage Publications,

Eze, C. C. &Njoku, Z. C. (2011*). Constraints on use of pupil-centred methods of teaching primary science and strategies for reform:* Views of primary school teachers of Igbo-Eze North Local Government Area of Enugu State. In Abonyi, O. S. (Ed.) *Science Teachers Association of Nigeria 52nd Annual Conference Proceedings*, pp. 330 – 334.

Ferk, V., Vrtačnik, M., Blejec, A., &Gril, A. (2003).Students understanding of molecular structure representations.*International Journal of Science education, 25*(10), 1227-1245.

Fessenden, J. R., & Fessenden, S. J. (1995).*Organic Chemistry (5ed.).* Belmont: Wadsworth, Inc.pp. 245-250.

Freedman, M. P. (1997).Relationship among laboratory instruction, attitude toward science, and achievement in science knowledge.*Journal of Research in Science Teaching, 34*(4), 343-357.

Fraenkel, J. R., &Wallen, N. E. (2009).*How to design and evaluate research in education*. pp.97-104, New York, NY: McGraw-Hill.

Frigg, R., & Hartmann, S. (2006).*Models in Science, Retrieved January 25, 2015, from the website: http://plato.stanford.edu/entries/models-science/#RepModIModPhe*

Gabel, D. L. & Bunce, D.M., (1994).*Handbook of Research on Science Teaching and Learning*. pp. 301-326, New York: Macmillan.

Gallagher, J. J. (2000*).*Teaching for understanding and application of science knowledge. *School Science and Mathematics Journal, 100*(6), 310-316.

Garrahy, D. (2001). Three third-grade teachers' gender-related beliefs and behaviours.*The Elementary School Journal, 102*(1):81-94.

Geddis, A. N. (1993). Transforming Content Knowledge: Learning to Teach about Isotopes. *Science Education, 77*, 575-591.

Gilbert, J. K. 2005. *Visualization in Science Education*.Netherlands.Springer. Johnson-Laird, P. 1996. "Images, Models, and Proportional Representations". In M. de Vega, M. J. Intons-Peterson, P.N. Johnson-Laird, M.

Gilbert, J.K., &Boulter, C.J. (1998).*Learning science through models and modeling*.In B.J.p 424-428.

Gillette, M. L (2004).*Introducing IUPAC nomenclature for organic chemical compounds*.*Retrieved October 08, 2010, from* http://www.cerlabs.com/Experiments/1053447599X.pdf

Gondgen,E. J., Gongen, J.J.,&Lohdip,Y.N.(2011). *Assessment of the difficult areas of the Senior Secondary School two chemistry syllabus of the Nigerian Science Curriculum*.Department of Chemistry and Department of Remedial Sciences. University of Jos.

Good, T.L. and Brophy, J.E. (1994), *Looking in Classrooms*, HarperCollins College Publishers, New York, NY.

Grossman, P. (1990). *The Making of a Teacher: Teacher Knowledge and Teacher Education*. New York: Teachers College Press p146-150.

Hardwicke, R. M. (1995). Using molecular models to teach chemistry .Part 1: modelling molecules .*School science review, 77* (278), 59-64.

Harrison, A. G. &Treagust, D. F., (1996). Secondary Students' Mental Models of Atoms and Molecules: *Implications for Teaching Chemistry*, *Science Education, 80*(5), 509–534.

Haussler, P., & Hoffmann L. (2002).An intervention study to enhance girls' interest, self-concept, and achievement in physics classes. Journal of Research in Science Teaching, 39, 870-888.

Heger, J. (2003). *Slovak nomenclature of organic Chemistry.Acta FacultatisPharmaceuticaeUniversitatisComenianae, 50,* 156-160.

Hines, C. (1990). Students' understanding of chemical equations in secondary schools in Botswana.*School Science Review, 72*(285), 138-140.

Hoffman, R.& Laszlo, P. (1991). *Representation in chemistry*.Angewandte ,chemie, International Edition English, 30:1-16.

Hofstein, A., Bybee, R. W., &Legro, P. (1992).Linking formal and informal science education through education standards .*Science Education International*, *8*(3), 31-37.

Ikeobi, I. O. (2010).*Beyond the Stereotype, Thoughts and Reflections on Education*. Lagos: The CIBN Press Ltd , 90-127

Jegede,S.A.(2007).Students' anxiety towards the learning of chemistry in some Nigerian Secondary Schools. *Education Research and Review, 2*(7) 193-197.

Johnstone, A. (2006). Chemical Education Research in Glasgow in Perspective. *Chemistry Education and Research Practice (7), 49 – 63.*

Johnstone, A.H. (1997). *Chemistry Teaching: Science or Alchemy*? *Journal of Chemical Education 74*, 262 – 68.

Joppe, M. (2000*).The research process.Retrieved December 17, 2009 from the website: http://www.ryerson.ca/~mjoppe/rp.htm*.

Justi, R. S., & Van Driel, J. H. (2005). The development of science teachers' knowledge on models and modelling: promoting, characterizing and understanding the process, *International Journal of Science Education*, *27,* 549-573.

Kahr, D., Triona, L. M., & Williams, C. (2006).Hands on what? The relative effectiveness of physical versus virtual materials in an engineering design project by middle school children. *Journal of Research in Science Teaching, 44*, 183-203.

Keig, P. F., & Rubba, P. A. (1993).Translation of representations of the structure of matter and its relationship to reasoning, gender, spatial reasoning, and specific prior knowledge. *Journal of Research in Science Teaching, 30*(8), 883-903.

Kessels, U. (2005). Fitting into the stereotype: How gender-stereotyped perceptions of prototypic peers relate to liking for school subjects. *European Journal of Psychology of Education, 20*, 309-323.

Kincheloe, J.L. (2000).*From Positivism to and Epistemology of complexity:* Grounding Rigorous Teaching. In standards and schooling in United States .volume 2.

Kirk, J, & Miller, M. L. (1999).*Reliability and validity in qualitative research*. Beverly Hills. Sage Publications.

Koch, J. (2005). *Science stories: science methods for elementary and middle school teachers*.(3rd ed.). New York: Houghton Miffin Company P 222-232.

Kozma, R. B., & Russell, J. (1999). Multimedia and understanding: Expert and novice responses to different representations of chemical phenomena. *Journal of Research in Science Teaching, 43, (9),*949-968

Krajcik, J .S (1999) .Developing students' understanding of concepts of chemistry. In Y. S. M. Glynn, R. H. Yanny & B. K. Britton (Eds.).*The psychology of learning* science*:* (pp.117-145), New Jersey.

Krajcik, J. S., & Soloway, E. (2001).*Promoting understanding of chemical representations*: *Students' use of a visualisation tool in the classroom*. *Journal of Research in Science Teaching, 38* (7), 821-842

Lankford, H., Loeb, S., & Wyckoff, J. (2002). Teacher sorting and the plight of urban schools: A descriptive analysis. *Educational Evaluation and Policy Analysis, 24*(1), 37-62

Magnusson, S., Krajcik, J., &Borko, H. (1994).*Nature, Sources, and Development of Pedagogical Content Knowledge for Science Teaching*. In J. Gess-Newsome & N. Lederman (Eds.), Year book of the association for the education of teachers of Science. Boston: Kluwer. 145-148.

Marks, R. (1991).*When Should Teachers Learn Pedagogical Content Knowledge?* East Lansing, MI: National Center for Research on Teacher Learning. (ERIC Document Reproduction Service No. ED335338) McGraw Hill.

Martin-Dunlop, C., & Fraser, B. J. (2008). Learning environment and attitudes associated with an innovative science course designed for prospective elementary teachers. *International Journal of Science and Mathematics Education, 6:*163-190.

Merriam, S. B. Caffarella, R. S., & Baumgartner, L. M. (2007*).Learning in adulthood: A comprehensive guide (3ed.).p.291*, San Francisco, CA: Jossey-Bass. 185-190

Ministry of Education, Science, and Sports [MOESS]. (2008*). Teaching syllabus for Chemistry.* Senior high school 2-4. Accra Curriculum Research and Development Division.

Muya, W. (2000, March 13). *KCPE Results*.Daily Nations. Nairobi: NMG.

Mwamwendwa, T. S. (2004). *Educational Psychology.An African Perspective*. London: Heinemann Butterworth Publisher Ltd.p 393-406

Myers, R. E., & Fouts, J. T. (1992).A cluster analysis of high school science classroom environments and attitude toward science *.Journal of Research in Science Teaching, 29*(9), 929-937.

Nakhleh, .M. B. & Amp; Krajcik; J. S. (1994). Influence of level of information as presented by different technologies on students understanding of accidents bases pH concepts. *Journal Research in science Teaching, 34* (10), 1077-1096

Njoku, Z. C. (2005). Investigation and analysis of topics which teachers perceive difficult to teach in the primary science curriculum. *Journal of the Science Teachers Association of Nigeria, 40* (1 & 2), 11 – 20.

Njoku, Z. C. (2007). Comparison of Students' achievement in the three categories ofquestions in SSCE practical chemistry examination.*Journal of the Science Teachers Association of Nigeria, 42* (1 & 2), 67 – 72.

Nwagbo, C. R. (2002). Level of scientific literacy of secondary school science students.Implications for sustainable development.*Annual Conference Proceedings of the Science Teachers Association of Nigeria,* 43, 73 – 77.

Nwosu, A. D. (2003). Constructivism as an innovative model for science teaching: Importance and extent of use in secondary schools. *Journal of the Science Teachers Association of Nigeria, 38* (1 & 2), 78 – 87.

O' Dwyer, A. & Childs, P. E (2010).*Second Level Irish pupils and Teacher's view of Difficulties in organic chemistry*. Published master's Thesis, University of Limerick, Ireland.

Obumnenye, O.; Ahiakwo, M. J. (2013).Using stereochemistry models in teaching organic compounds nomenclature: effects on senior secondary students' performance in rivers state of Nigeria. *AJCE, 2013, 3 (2)*, 91-105.

Oluwatelure, T. A. &Oloruntegbe, K. O. (2009). Effects of parental involvement on students attitude and performance in science .*African Journal of Microbiology Research, 4*(1), 1-9

Osborne, J., & Collins, S. (2001). *Pupils' and parents' views of the school science curriculum.* London: King's College London. P387–398

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education, 25*(9), 1049–1079.

Pemida, R. O. (2005). Achieving the objectives of teacher education in contemporary Nigeria; status and prospects. *Nigerian Journal of Science and Educational Research (NIJORSER) 1* (2), 1 –6.

Peterson, Q. R. (1970).Some reflections on the use and abuse of molecular models.*Journal of Chemical Education, 47*, 24-29.

Petty, R. (1995). *Attitude change*. In A. Tesser (Ed.), advanced social psychology, New York p 24-29.

Piburn, M. D. & Baker J (1993). If I were the teacher.Qualitative study of attitude toward science.*Science Education, 77*(4), 393-406.

Polkinghorne, J. C. (1989). *The quantum world*: Princeton University project-based learning in an IT environment. *Science Education*, *89*(1), 117-139.

Pollard, A. &Triggs, P. with Broadfoot, P., McNess, E. and Osborn, M. (2000).*What Pupils Say: Changing Policy and Practice in Primary Education*. London: Continuum.p117-139.

Raghavan, K., & Glaser, R. (1995). Model based analysis and reasoning in science: the MARS curriculum. *Science Education, 79*, 37-61.

Reiss, J. (2003). *Causal inference in the abstract or seven myths about thought experiments. In Causality: Metaphysics and Methods Research Project.* Technical Report 03/02. LSE.211Johnson-Laird, P. N. 1996. "Images, Mod Proportional Representations". In M. de Vega, M. J. Intons-Peterson, P.N. Johnson-Laird, M. Cartier, J., J. Rudolph, and J. Stewart. 2001. NCISLA, Wisconsin Center for Education Research. Wisconsin: University of Wisconsin–Madison.

Salta, K., &Tzougraki, C. (2004).Attitudes toward chemistry among 11 the grade students in high schools in Greece.*Science Education, 88*,535–547

Sarantakos, R. (1998). *Research methods in schools.* Boston: Fordana Academic Publisher .p552-558.

Shulman, L. S. (1987). Those Who Understand: Knowledge Growth in Teaching. *Educational Researcher, 15*(2), 4-14

Shulman, L., & Grossman, P. (1988).*The Intern Teacher Casebook*. San Francisco, CA: Far Wets Laboratory for Educational Research and Development.p248-251.

Simpkins, S. D., Davis-Kean, P. E., &Eccles, J.S. (2006). Math and science motivation: A longitudinal examination of the links between choices and beliefs. *Developmental Psychology, 42*, (3) 70-83.

Simpson, R. D. & Oliver, J. S. (1990).A summary of major influences on attitude toward and achievement in science among adolescent students. *Science Education, 74*(1), 1-18.

Siti Norliana Ghazali. (2008). Learner background and their attitudes towards studying literature.*Malaysian Journal of ELT research, 4*, (2) 1-17.

Solomons, T. W., &Fryhle, C. B. (2013).*Organic Chemistry (11ed.).* Hoboken, NJ: John Wiley & Sons, Inc p83-89.

Stake, J. E. (2006).The critical mediating role of social encouragement for science motivation and confidence among high school girls and boys. *Journal of Applied Social Psychology, 36*,(2) 1017-1045.

Swan, K. (2005). *A constructivist model for thinking about learning online.* In J.Bourne,& J. C. Moore (Eds.*), Elements of Quality Online Education: Engaging Communities, (pp. 1-19).* Needham, MA: Sloan-C. 135

Tasker, R., & Dalton, R. (2006). Research into practice: visualisation of the molecular world using animations, *Chemistry Education Research and Practice,* ***7***, 141-159.

Thayer-Bacon, Barbara. (1999). The Thinker versus a Quilting Bee: Contrasting Images. *Educational Foundations*, *13*: 47-65.

Tobin, K., Tippins, D. J. &Gallard, A. J. (1994*).Research on instructional strategies for teaching science. In D. L. Gabel* (Ed).Handbook on research in science teaching and learning (pp. 45-93). Upper Saddle River: Prentice.

Tsabari, A. B., Sethi, R. J., Bry, L., &Yarden, A. (2006). Using questions sent to an ask-a-scientist site to identify children's interests in science. Wiley InterScience, 1050-1072.

Turner, R. C. & Lindsay, H. A. (2003). Gender differences in cognitive and non-cognitive factors related to achievement in organic chemistry. *Journal of Chemical Education, 80(5), 563-568.*

. Ward, H., Roden, J., Hewlett, C. & Foreman, J. (2005). *Teaching science in the primary classroom: A practical guide* .London: Paul Chapman Publishing.p63-68.

West Africa Examinations Council, Ghana [WAEC]. (2010b*). Register of programmes and courses for public and private senior high schools technical and vocational institutions.* Accra: WAEC

West African Examination Council.(2004). *Chief Examiners Report for July / August SHS Chemistry.*

West African Examination Council. (2006). *Chief Examiners Report for May / June SHS Chemistry.*

West African Examinations Council [WAEC]. (2001). *Chief examiners reports*: July/August senior secondary school certificate examination. Accra:

West African Examinations Council [WAEC]. (2002). *Chief examiners' reports: July/August senior secondary school certificate examination. Accra: WAEC*

Windschitl, M. (1999).*The challenges of sustaining constructivist classroom culture*.Phi delta Kappan. 80:751-757.

Woolfolk, A. (2007). *Educational Psychology (10ed.*). New York: Pearson Education, Inc. P 51-55.

Zumdahl, S. S. (2000), *introductory chemistry (4^{th}ed.).* Boston: Houghton Mifflin Company.524-528.

APPENDICES

APPENDIX A

TEST ITEMS ON THEIUPAC NAMING OF ORGANIC COMPOUNDS

ANSWER EACH QUESTION ITEM AS CORRECTLY AS YOU CAN

TIME; 60 MINUTES

Give the IUPAC name of each of the following organic compounds in the spaces provided:

1. $CH_3CH_2CH(CH_3)_2$

   ……………………………………………………………………………

2. $CH_3CHClCH_2CH_3$

   ………………………………………………………………………………

3. $CH_3(CH_2)_4CH_3$

   ……………………………………………………………………………

4. $CH_2COOCH_2CH_3$

   ………………………………………………………………………………

5. $CH_2ClCOOH$

   ………………………………………………………………………………

6. $CH_2ICHFCH_2OH$

   ………………………………………………………………………………

7. $CH_3CH_2C(OH)\ (CH_3)CH_2CH_3$

   ………………………………………………………………………………

8. $CH_3CH_2CH(OH)\ CH_3$

   ………………………………………………………………………………

9. CH_2CHCH_3

   ………………………………………………………………………………

10. CH_3CH_2CCH

………………………………………………………………………………………

11. $CH_3CH_2CH_2CH{=}CHCH_3$

………………………………………………………………………………………

12. CH_2ICH_2I

………………………………………………………………………………………

13. $CH_3CCCHClCH_3$

………………………………………………………………………………………

14. $CH_3CH_2COOCH_3$

………………………………………………………………………………………

15. $CH_3CHBrC(CH_3)_3$………………………………………………………………

…………………

16. $CH_3CH_2CH_2CH_3$

………………………………………………………………………………………

17. $CH_3CBr_2CH_2F$

………………………………………………………………………………………

18. $CCl_3\,CBr_2CH_2F$

………………………………………………………………………………………

19. $CH_3CH_2COOCH_2CH_2CH_2CH_3$

………………………………………………………………………………………

20. $CHBr_2C(CH_3)_3$

………………………………………………………………………………………

Write the condensed formula for each of the following organic compounds;

21.2-pentene……………………………………………………………………………

22 Pentanoic acid……………………………………………………………….

23. 4-methylhex-2-yne…………………………………………………………

24. Methyl methanoate……………………………………………………………

25. 2-methylpropanol………………………………………………………………

Draw the structural formulae of the following organic compounds

26. Ethanoic acids………………………………………………………………………

27. Heptan-3-ol…………………………………………………………………………

28.4-ethyl-2, 3-dimethylhex-2-ene…………………………………………………..

29. 2-fluoro-3, 3-dimethylbutane…………………………………………………

30. 5- methylhe-2-yne……………………………………………………….

APPENDIX B

Dear respondent,

This study is purely academic purposes. Kindly provides honest responses to each item below.

Please indicate the extent to which you agree with the item .In each case tick *(√)* in the appropriate box.

Table 1 Students' Attitudes towards systematic naming of Organic Compounds

Pre-test						**Post-test**				
SD (1)	**D (2)**	**NS (3)**	**A (4)**	**SA (5)**		**SD (1)**	**D (2)**	**NS (3)**	**A (4)**	**SA (5)**
					1. I look forward to (eagerly anticipate) the next lesson on IUPAC nomenclature of organic compounds					
					2. Lessons on systematic naming on organic compounds were fun.					
					3. I enjoyed being in the class.					
					4. Lessons in the class were a waste of time					
					5. Lessons in the class bored me					
					6. The lessons made me interested in IUPAC nomenclature of organic compounds.					
					7. One of the most interesting classes was naming of organic compounds lessons.					

APPENDIX C

Table of Scores

Control Group		Experimental Group	
Pre-test	Post-test	Pre-test	Post-test
23	27	27	40
24	25	24	35
23	29	26	38
28	28	31	45
26	27	29	37
24	25	28	43
29	30	24	38
24	25	22	34
26	24	22	32
24	26	24	36
25	29	30	41
32	35	26	39
27	28	27	41
29	31	22	33
28	25	32	46
22	25	27	38
28	26	26	36
27	29	24	36
26	30	24	37
28	28	28	41
29	27	28	44
27	28	28	40
22	26	29	42
24	28	27	38
26	27	26	37
25	28	25	30
31	33	22	33
22	26	22	32
22	23	24	35
23	25	25	30
25	26	23	32
24	26	23	31
22	24	23	31
23	27	22	29
23	25	24	32
23	26	24	31
24	28	22	30
26	27	23	33
27	23	26	35
25	28	24	32
23	29	23	34