UNIVERSITY OF EDUCATION, WINNEBA

EFFECT OF MOLECULAR MODEL KITS ON NAMING ORGANIC COMPOUNDS IN CHEMISTRY AMONGST WINNEBA SENIOR HIGH SCHOOL STUDENTS

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SEPTEMBER, 2022

DECLARATION

Student's Declaration

I, Martin Kwesi Beyamfui, declare that this dissertation with the exception of quotation and references contained in published works have been identified and acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for 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 and supervision of thesis laid down by the University of Education, Winneba.

Name: Dr. Paul Kobina Effrim

Signature……………………………………….

Date…………………………………...……..

DEDICATION

To my wife, Mrs Millicent Beyamfui and my daughter Kaziah Faith Maame Kumaah Beyamfui.

ACKNOWLEDGEMENTS

I would like to express my immeasurable appreciation to Dr. Paul Kobina Effrim, lecturer at the Department of Educational Foundations, University of Education, Winneba, for his guidance and patience, in helping me to complete my project work.

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ABSTACT

The study examined effect of molecular model kits on naming organic compounds in Chemistry amongst Winneba Senior School Students in the Effutu Municipality. Simple random sampling technique was used to draw a sample size of 44 for the study. Students were taken through a lot of intervention activities using the molecular Model kits. Questionnaire and achievement test were used as an instrument for data collection and the findings were analysed using frequencies and percentages. Descriptive statistics was used to analyze the Pre-test and the Post-test. The Statistical Package for Social Scientist (SPSS) was also employed to analyze the Pre-test and the Post-test scores by the students quantitatively using paired sample t-test. The major findings revealed that the models were effective in teaching and learning of IUPAC nomenclature of hydrocarbons. Further, the results showed that most of the students exhibited positive attitudes towards the use of the molecular model kits. The study recommends that chemistry teachers should be encouraged to incorporate teaching and learning materials in teaching concepts to make it as practical as possible. Also, educational programmes, workshops and seminars on the use of molecular model kits and other strategies should be organized for teachers on their effective use for teaching in the chemistry classroom.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter presents the background to the study, statement of the problem, purpose of the study, objectives of the study, research questions, research hypothesis, significance of the study, limitations and as well as delimitations.

1.1 Background to the Study

Students process similar information in different ways. This is because students hail from different backgrounds, this cause them to have divers' opinions on subject of interest. These experience enable them to embrace new concepts or impede what is yet to be acquired. If knowledge is appropriately delivered to students, it limits the misconceptions and it will give room for innovative ideas coupled with creativity. A prolific result can be realized within a specific time when there is a proper coordination between students and the teacher. According to Almulla (2020), to facilitate education that is inviting to students and responsive to students' ideas, students must perform authentic, meaningful tasks that encourages them to generate new ideas. This is the reason why teachers should introduce different formats and models to teaching the subject of study so that learners can discover new ideas and appreciate what is being thought. This is what we call discovery learning. Discovery learning paves way for useful application of information which leads to innovation. For many years, scientists and educators all around the globe have been looking for strategies to assist pupils gain a meaningful mental grasp of chemical representations (Gkitzia & Salta, 2019).

Three levels of representation have been considered in the study of organic chemistry: macroscopic, submicroscopic, and symbolic representations (Talanquer, 2011). According to Talanquer (2011) the nature of the macroscopic level has also been the subject of various interpretations. Some writers define the macroscopic level as the level of the observable and tangible things that we encounter in our daily lives or in the lab (Wei, Liu, & Jia, 2014). Others, on the other hand, consider the macro level as representational in nature, influenced primarily by the concepts and ideas used to explain bulk matter qualities like pH, temperature, pressure, density, and concentration (Talanquer, 2011).

The submicroscopic and symbolic levels of representing chemical concepts have long been identified as potentially difficult areas as far as students' learning science are concerned (Ben-Zvi et al., 1987). The difficulty associated with these two levels is as a result of the abstract nature of the teaching of such chemical concepts and students most of the time are pivoted at learning chemical concepts using everyday observations (Ben-Zvi et al., 1986). Wu et al. (2001) noted that, the difficulty is as result of the fact that students view equations or formulae of chemical substances as combination of letters and numbers while Keig & Rubba (1993) viewed the difficulty as a result of students' inability to translate one representation into another. Calik & Ayas (2005) further explained that the difficulty for students in learning chemical concepts is as a result of their inability to show linkages between knowledge acquired and everyday experience. Kozma et al. (2000) identified that the students' difficulty in learning chemical concepts is partly due to the fact that students cannot directly perceive molecules and their properties.

Hydrocarbons are organic compounds composing of only carbon and hydrogen atoms, for example, CH_4, CH_3CH_3, $CH_2{=}CH_2$, $CH{\equiv}CH$, and C_6H_6. Hydrocarbons can either be alkanes, which contain carbon-carbon single bonds; alkenes, which contain at least one carbon-carbon double bond; or alkynes, which contain a carbon-carbon triple bond (Fessenden & Fessenden, 1990; Solomons & Fryhle, 2008). There are two groups of hydrocarbons; namely saturated and unsaturated hydrocarbons, however, each carbon atom has to maintain tetravalency that is having four covalent bonds attached to the carbon atom in a molecule. In the saturated hydrocarbons or alkanes, all the four bonds around any carbon atom in the molecules are single bonds and in the unsaturated hydrocarbons (alkenes and alkynes), there is always a carbon-carbon multiple bonds in the molecule. The structure and naming of hydrocarbons serve as the foundation for moving to similar tasks for organic compounds containing other functional groups (Fessenden & Fessenden, 1990). Naming and drawing of hydrocarbons, like all other chemical concepts at the symbolic level are associated with some degree of difficulty in learning with respect to their structures, equations, and chemical reactions.

Kozma et al. (2000) realised that the name of a compound could account for the different atoms present in that compound as well as its physical properties. In addition, the name of a structure of a compound would in some cases reflect the elemental components of that compound. Thus, the act of naming a compound is not necessarily giving the compound an IUPAC name but the name should be unambiguous with respect to the structure of the compound (Kozma et al., 2000). Ege (as cited in Kozma et al., 2000) stated emphatically that scientists cannot talk about Organic Chemistry relegating structural diagrams to the background, that is chemical scientists in the area of Organic Chemistry always draw molecular structures for the reactions they talk about. This is because molecular structures of compounds help to identify the constituent atoms, the relative spatial arrangement of the atoms, and the chemical bonding between the atoms.

The IUPAC nomenclature of organic compounds has been with us for many years (Fessenden & Fessenden, 1990; Solomons & Fryhle, 2008) and the current IUPAC rules were updated in 1993. In Ghana IUPAC nomenclature is taught in high school through to the university in subjects such as Integrated Science and Chemistry. The West African Examination Council (WAEC) Chief Examiners' Reports have over the years reported on the low performance of candidates in Integrated Science 1 at high school level. This is particularly evident in the area of chemical concepts (WAEC, 2002; 2005; 2006; 2008; 2010). The Chief Examiner (CE) in 2005 explained that there had been improvement in candidates' performance in Integrated Science 1. However, the CE identified that the number of candidates who answered the question on Chemistry aspects was very low and such candidates showed poor performance in such areas. For instance, the candidates could not even explain correctly the concept of IUPAC nomenclature when they were asked to do so. In 2006, the CE asserted that the candidates could not clearly show the difference between organic compounds in general and hydrocarbons, in particular the candidates were seen to be faltering in providing the IUPAC names of sample organic compounds. An empirical study of Adu-Gyamfi et al. (2013) further exposed the weakness of senior high school (SHS) students in using the IUPAC nomenclature system to name and write formulae of organic compounds. This identified weakness is common for both hydrocarbons and non-hydrocarbons such as alkanols, alkanoic acids, and alkyl alkanoates. The students' difficulties in using IUPAC nomenclature in drawing structural formulae of organic compounds stem from the fact they could not identify the correct number of carbons in a continuous chain as well as any substituent group and its point of attachment from the IUPAC name when drawing the structures (Adu-Gyamfi et al., 2012).

1.2 Statement of the Problem

Some of the general aims in the new chemistry syllabus are: to use appropriate numeric, symbolic, nomenclature and graphic modes of representation and appropriate units of measurement and also develop the ability to communicate ideas, plans, procedures, results, and conclusions of investigations orally, in writing, and/or in electronic presentations, using appropriate language and a variety of formats e.g. data, tables, laboratory reports, presentations, debates and models.

Over the years, the West African Examination Council (WAEC) Chemistry Chief Examiner's Report lamented on the inability of chemistry students to meet the general aims of the chemistry syllabus especially in organic chemistry. According to the report, most of the students even avoid organic chemistry questions and the few that tackle organic chemistry questions also do not get the naming correct except on rare cases. Naming of organic compounds when the formula is given and writing of the formula from a named compound are key to the mastery of the naming organic compounds. He attributed this to the fact that most teachers do not teach those organic chemistry topics since they are at the latter part of the syllabus and even when they do, it is done very close to the final examination. The WAEC Chemistry Chief Examiner's report in Ghana has over the years lamented on the weakness of most students in IUPAC nomenclature of organic compounds (WAEC, 2005; 2006; 2010). In 2015, the Chief Examiner's report showed that many candidates attempted questions on the naming of organic compounds but could not give the IUPAC names of the compounds correctly. In 2017, the report showed that candidates showed weakness as in IUPAC naming of simple organic compounds. For example, most candidates could not name C_6H_5Cl as chlorobenzene. For example, in 2005, candidates could not write the correct IUPAC names of, $HCOOCH_3$,$CH_3CHOHCH_2O$ and C_6H_5COOH as methyl methanoate, propan-1, 2-diol and phenylmethanoic acid respectively.

This problematic situation exists in the researcher's school. Since organic Chemistry is an important aspect of the Senior High School chemistry programme, it is necessary for workable solutions to be found for the challenges students face in naming organic compounds using the IUPAC system of nomenclature. For this reason, this study was design to explore the effect of molecular model kits on selected SHS students' ability to name organic compounds using the IUPAC system of nomenclature.

1.3 Purpose of the Study

The purpose of this research was to determine whether there was a significant difference in the performance of students taught naming and writing of structural formulae of hydrocarbons using the molecular model kits. Additionally, the study sought to explore the use of the molecular model kits to address the difficulties of final year students of Winneba Secondary School in naming and writing the structural formulae for hydrocarbons.

1.4 Objectives of the Study

The study sought to find out:

1. The attitude of students towards naming and writing of structural formulae of hydrocarbons
2. How the use of the molecular model kits would improve students' performance in naming and writing of structural formulae of hydrocarbons.

1.5 Research Questions

1. What is the attitude of students towards naming and writing of structural formulae of hydrocarbons?
2. How effective is the use of molecular model kits in improving students' performance in naming and writing of structural formulae of hydrocarbons?

1.6 Research Hypothesis

The following were the research or the alternative hypothesis(H_a) of the study:

H_a: There is statistically a significant difference in the performance of students taught using the molecular model kits and those taught without molecular kits model.

H_a: There is statistically a significant difference in the attitude of students towards naming and writing of structural formulae of hydrocarbons.

1.8 Null Hypothesis

1. H_o: There is no significant difference in the performance of students taught using the molecular model kits and those taught without the molecular kits model.

H_o: There is no significant difference in the attitude of students towards naming and writing of structural formulae of hydrocarbons.

1.7 Significance of the Study

The outcome of this study could help chemistry teachers, heads of science departments and anybody who in one way or the other contribute to education in Ghana incorporate new methods of teaching so as to satisfy the needs of the learners. The study could further provide chemistry educators with quantitative data as to how students appreciate and understand the IUPAC system of naming.

1.8 Delimitations of the Study

The study was limited to students offering General Science programme in the Winneba Senior High School. Students who have some background from their Integrated Science lessons were not included in the study. The study also concentrated on the effective use of the molecular model kits in teaching naming and writing of structural formulae of hydrocarbons, specifically, the Effutu municipality.

1.9 Organization of the Study

This study is arranged in five chapters. The first chapter contains the introduction, which comprises the background of the study, statement of the problem, objectives of the study, research questions, hypothesis and organization of study. The second chapter contains the literature review, which comprises of empirical review of works concerning the study. Chapter three comprises the research methodology of the study. Chapter four contains the results and analysis of the study. Chapter five contains summary of findings, conclusion and recommendations of the study.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.0 Overview

This chapter is devoted to the relevant materials that were reviewed for this study. Review of related literature was done considering the following salient materials

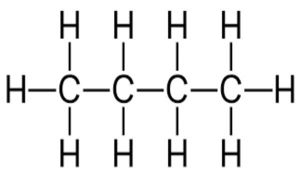
2.1 Organic Compounds

Organic compound is a chemical compound in which one or more atoms of carbon are covalently linked to atoms of other elements, most commonly hydrogen, oxygen, or nitrogen. The few carbon-containing compounds not classified as organic include carbides, carbonates, and cynide etc.

Organic compounds are be classified as aliphatic compounds, Alicyclic compounds, Heterocyclic compounds and Aromatic compounds.

2.1.1 Aliphatic COMPOUNDS

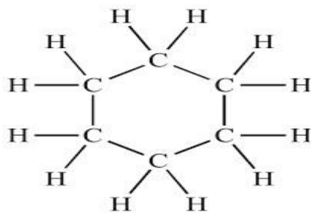
They are organic compounds with carbon atoms arranged in an open chain. These compounds can be straight or branched chain and contains single, double or triple carbon-carbon bonds.



Butane

2.1.2 Alicyclic compounds

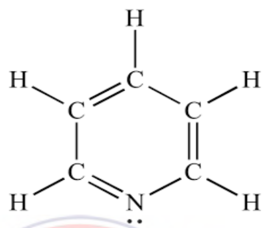
They are organic compounds with carbon atoms in a closed ring. In this type of organic compound the bonding electrons of the carbon atoms are localized between the atoms.



Cyclohexane

2.1.3 Heterocyclic compounds

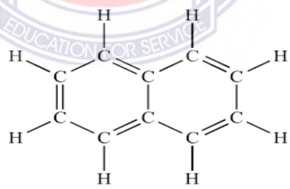
They are organic compounds which contains rings of carbon atoms and other atoms especially heteroatoms like oxygen, nitrogen or Sulphur.



Pyridine

2.1.4 Aromatic compounds

They are organic compounds which contain at least one benzene ring.



2.2 IUPAC Nomenclature of Organic Compounds

The concept IUPAC nomenclature, which is a formal system of naming organic compounds, was introduced in 1892 by the International Union of Pure and Applied Chemistry (IUPAC) (Fessenden & Fessenden, 1990; Gillette 2004; Adu-Gyamfi, Ampiah & Appiah, 2013; Solomons & Fryhle, 2008). According to Adu-Gyamfi, Ampiah and Appiah (2013), there were other systems of naming that came before the emergence of IUPAC system and as such IUPAC names may not be the most commonly used one. Klinger, Kolarik, Fluck, Hofmann-Apitus and Friedrich (2008) noted: “trivial names can be searched for with a dictionary-based approach and directly mapped to the corresponding structure at the same time” (p. I268). But IUPAC and the IUPAC related names are identified with respect to the structure of the organic compound (Kolarik et al., as cited in Klinger et al., 2008).

In using the IUPAC nomenclature system to name and write structural formulae of organic compounds, the functional group (which is defined as an atom or group of atoms responsible for the chemical behavior of organic compounds) of a compound is taking into consideration (Gillette, 2004). For example, all alkenes, alkynes and alkanosl contain R2-C=C-R2, R–C ≡ C–R and (─OH) group respectively bonded to carbon atom where ‘R’ can be Hydrogen or alkyl group. According to Skonieczy (2006), preference should always be given to a functional group that has the highest precedence when the organic molecule in question contains more than one functional group.

Students’ ability to interpret the IUPAC name of an organic compound into its structural formula is the most important compared to the ability of Chemistry students to give the IUPAC name of any given structural formula. In any chemistry examination, if students find it difficult to write a structural formula of any named compound, then they will as well find it difficult to name it since most of the functional groups are hidden in the condense formula as well as the substituents. Therefore, if this happens, the performance of such students is affected on such questions (Clark, 2000). Adu-Gyamfi, Ampiah and Appiah (2013) indicated that, though almost every organic compound contains carbon and hydrogen atoms but the IUPAC names of the organic compounds are determined partly by the number of carbon atoms in the longest continuous carbon chain, and other element and group of elements such as functional groups and substituents Adu-Gyamfi, Ampiah, & Appiah, (2013). The name is actually silent on the name of hydrogen. In naming organic compounds, there are three parts that must be considered. These are the root (parent) part; which shows the number of carbon atoms in the longest continuous carbon chain, the suffix which shows the family to which the organic compound belongs or the functional group it contains. The third part is prefix; which is dependent upon the number, position of both organic and inorganic substituents that replaced any hydrogen atom or atoms in the parent compound (Adu-Gyamfi, Ampiah, & Appiah, 2013; Woodcock, 1996). Gillette (2004) stressed that if any chemistry student is able to apply and interpret these three parts of organic compounds, then he or she will be able to "write the IUPAC names of organic compounds base on their Lewis structures; and draw the Lewis structures for organic compounds based on their IUPAC names. The same will be true for condensed formulae and line-angle drawings". Gillette (2004) also stated that there are three ways of representing the IUPAC names of organic compounds with structural formulae. The first is the Lewis dot structure (referred to as expanded structural formula). The Lewis structure shows all the carbon and hydrogen atoms together with any other atom or group of atoms and the covalent bonds connecting them. The second structure is the condensed structural formula, which shows any carbon atoms in the straight chain together with any other atoms or group of atoms connecting to the chain without the covalent bonds or any unshared electron pairs. In the condensed structural formula, the covalent bond is shown only and if only there is the need to clarify a specific portion of the structure for example functional groups (Gillette, 2004). In the line angle drawing, chemical bonds are shown without the carbon and hydrogen atoms, it uses lines to show chemical bonds. This is the third structural formula representation (Gillette, 2004).

Gillette further mentioned that, irrespective of the method of structural formula used for any particular compound, the presence of any oth er atom or group of atoms or any multiple bond/s in any particular molecule must be shown. For example, $CH_3CH{=}CHCH_3$. Gillette (2004) said "to draw the structure of an IUPAC-named compound, we work backwards through the compound name, from the parent name to the prefix" (p. 7). 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 the number of carbon atoms in the longest continuous carbon chain (and in this instance, there are four atoms of carbon) (Clark, 2000).
2. The –ane comes immediately after the 'but' shows there is no carbon to carbon multiple bond (Clark, 2000).
3. The 2-methyl shows there is a methyl substituent group which is attached to the second carbon.
4. The -1-ol shows that, there is alkanol functional group attached to the terminal end of the compound.

Clark (2000), was of the view that one has to learn the codes for number of carbon atoms in a continuous carbon chain in order to master naming organic compounds.

Table 2.1 shows the parent name for a particular carbon length in organic compounds.

Table 2.1: The prefix of Carbon-Carbon Bonds

Prefix	Number of Carbons
Meth-	1
Eth-	2
Prop-	3
But-	4
Pent-	5
Hex-	6
Hept-	7
Oct-	8
Non-	9
Dec-	10

Clark (2000) indicated that if an organic compound contains a carbon-carbon single or multiple bonds, the three letters that come immediately after the parent name (suffix) for the chain length will give an indication. Data in Table 2 shows the suffix for carbon-carbon single and multiple bonds.

Table 2.2: The suffix of Carbon-Carbon Bonds

Suffix	Interpretation
- ane	The molecule contains only carbon-carbon single bonds
-ene	The molecule contains only carbon-carbon double bonds
-yne	The molecule contains only carbon-carbon triple bonds
-ol	The molecule contains alcohol functional group

2.2.1 Suffix interpretation

In naming a typical alkane, for example $CH_3CH(CH_3)CH_2CH_3$ is name as 2-methyl-butane. To be able to name this compound, the longest continuous carbon chain was determined to be 4 and hence the parent name but-, from the structural formula, the functional group was indicated to be alkane functional group and located at position one on the chain. There is only one organic substituent which is a methyl group and it is also located on the second carbon on the chain. All these informations were put together in naming the compound above.

2.3 Academic Performance

Academic performance has been defined and explained by several authors. According to Narad and Abdullah (2016) academic performance is the knowledge gained which is assessed by marks by a teacher and or educational goals set by students and teachers to be achieved over a specific period of time. They added that these goals are measured by using continuous assessment or examination results. Annie, Howard and Midred (as cited in Arshad, Zaidi & Mahmood, 2015) also indicated that academic performances measures education outcome. The definitions given by the authors shows that the definition of academic performance is based on measurable outcome such as class exercise, test and examination results.

2.3.1 Factors contributing to academic performance

Several studies have been conducted in different countries to assess the factors which contribute to academic performance of students at different levels. In Pakististan, Farooq, Chaudhry, Shafiq and Berhanu (2011) found that parents' education and socio- economic status have been significnant on academic performance in Mathematics and English Language. A study conducted by Jayanthi, Balakrishnan, Ching, Lattif and Nasirudeen (2014) in Singapore revealed that the interest in pursuing a subject, co-curricular activities, nationality of a student and gender affect academic performance of a student. Positive classroom environment has also been found as determining factor of academic performance. Furthermore, students' personality traits, personal goals and motivation as well as the support from teachers and the teacher's level of experience significantly influence the academic performance of students (Ulate & Carballo, 2012).

The discussion above suggests that the academic performance of students is influenced by a combination of factors which includes but not limited to: parents' level of education, socio-economic status, interest of the subject, gender, availability of teaching and learning materials, punctuality in class, regular studying, students attitude towards the subject and competence of teachers. These factors could be classified into student, teacher, school and parent factors.

2.3.2 Student factors which contribute to academic performance

From the discussion above, it is evident that students play a critical role towards their academic performance. Students' factors such as developing interest in a subject, attitude towards the subject, engaging in co-curricular activities (Javanthi et al. 2014), regular studying, self-motivation and punctuality in school.

The attitude of students towards their learning have been found to have a significant relationship with their academic performance. For example, Awang, Ahmad, Bakar, Ghani, Yunus et al. (2013) found that there is a statistical significant relationship difference between students' attitudes towards their learning and academic performance. Janssen and O' Brien (2014) argued that although students learning has an impact on academic performance, it is indirect. Notwithstanding their findings, Manoah, Indoshi and Othuon (2011) confirmed that in the case of the mathematics, students' attitude towards the subject has a direct impact on their academic performance. However, Rono and Langat (2015) found that students who had positive attitude towards mathematics did not affect their academic score.

Nielson, Atkin and Winge (1985), observed that the grades of good students depend on how prepared and willing they are to apply themselves to study in schools. He further observes that by simply making an increase in the time students spend on homework can positively affect their grades in high school. All these observations points to the fact that attitude of students have profound impact on their school performance. Students who have been most successful in school usually have a more positive attitude towards school than those who have not been successful (Avramidis & Norwich, 2002).

2.3.3 Parent factors which contribute to academic performance

Recent studies have found that parental involvement have a positive impact on the academic performance of their wards. McNeal (2014) for example, revealed that the involvement of parents towards their wards performance is categorized into home-based involvement and school - based involvement. Their study revealed that the home-based involvement has a positive significant relationship with their wards academic performance but there is a negative relationship between school-based parental involvement and academic performance. Niemeyer, Wong and Westerhaus (2009) emphasized that students with high level of parental involvement in their academics perform significantly better than those with no parental involvement.

Students' academic performance can be influenced by genetic factors that is whether the student inherits higher intelligence or a lower one. Learners who have inherited higher intelligence have higher intellectual efficiency (Vernon, 2014). They are able to learn quickly and progress to a higher stages of the educational ladder. With such students since transfer of learning depends on perception of relationships between situations, they are able to connect the relationship between what they learn easily. Students of such nature can see the connections between two or more different situations and common elements and pervasive principles without the teacher's intervention.

2.3.4 Teacher factors that affect academic performance

Teachers play a vital role towards the academic performance of students. A study conducted by Kimani, Kara and Njagi (2013) in Kenya on teacher factors influencing academic achievement, found that age, gender and professional qualification had no statistical significant relationship with academic performance of students. However, they noticed that performance targets, completion of syllabus, paying attention to weak students, assignments, student evaluation, and the teaching workload of a teacher had significant relationship with students' academic performance. Ganyaupfu (2013) on the other hand asserted that combination of teacher and student centred method have a positive effect on academic performance. They concluded that the student centred method is more effective than the teacher approach. Musili (2015) added that teacher experience and professional training have a significant impact on students' performance. Blazar (2016) confirmed that the impact teachers' have on the academic performance of their students is substantial. But stressed that little is known about the specific teacher factors which contributes to the academic performance of students.

2.4 The Inadequate Time Allocation for Chemistry

The West African Examination Council (WAEC) (2006) Chief Examiner's in Chemistry stressed that the syllabus was not completed enough before writing the final examination. This is because the time period for teaching all the topics in the theory and the practical is not enough. The normal curriculum is now embedded with so many extra-curriculum activities there by reducing the contact hours for teaching. Those who think that, time is a valuable resource and therefore have their activities regulated by the clock share this ideology. Time is a non- renewable resource and once it is lost, it cannot be gained back by any other means.

2.5 Chemistry Students' Performance in IUPAC Nomenclature of Organic Compound

Considering the research work done by Tal and Steiner (2006) it has revealed that the performance of science students depends on several factors of which the school environment, teaching and learning materials and equipment are not exceptions. This gives an indication that the type of school attended by a student has as an influence on his or her performance in IUPAC nomenclature of organic compounds.

Baah and Anthony-Krueger (2012) study conducted in Ghana found the following: The performance of students from Grade A schools and Grade B schools on naming of compounds by IUPAC nomenclature differed significantly with students from Grade A schools doing better. This is because the mean score for students from Grade A schools ($M = 3.80$, $SD = 1.76$) was significantly higher than the mean score of students from Grade B schools ($M = 2.085$, $SD = 1.710$, $t(332) = 8.734$, $p = 0.001$) with an effect size of 1.0 (p. 122). Baah and Anthony-Krueger (2012) further found that chemistry students from Grade B schools performed significantly less on writing chemical formulae of compounds and on writing chemical equations as compared to their colleagues from Grade A schools. Under the writing of chemical formulae of compounds, Baah reported that the chemistry students from the Grade A schools recorded significantly higher mean score (M = 2.200, SD = 1.669) as compared to the mean score of chemistry students from Grade B schools (M = 0.940, SD = 1.184, t(332) = 1.454, p = 0.001) with 0.8 as the effect size. Under the writing of the chemical equations there was a significant difference between chemistry students from Grade B schools and Grade A schools because the mean score (M = 8.493, SD = 3.357) of chemistry students from the Grade A schools was significantly higher than the mean score (M = 6.364, SD = 3.002, t(332) = 5.872, p = 0.001) with effect size of 0.7 of chemistry students from Grade B schools (Baah, 2009). Wu, Krajcik, and Soloway (2001) indicated that many students studying chemistry have difficulty learning symbolic and molecular representations. They have conducted a study with 71 eleventh grade students of small public high school in a midsize university town in the Midwest to investigate how chemistry students develop and understand chemical representations using a computer-based visualizing tool for 6 weeks. One of the chemical concepts studied within the 6 weeks' period by Wu et al. (2001) was IUPAC nomenclature of organic compounds such as hydrocarbons. According to Fendos (2021), students were able to apply modern rules of IUPAC nomenclature to draw structures of some given organic compounds. For instance, the students were made to name and draw the structure of a six carbon atom compound with a side group. The understanding of the high school chemistry students was said to have improved considerably resulting in high performance on IUPAC nomenclature of organic compounds. This is as a result of the fact that, there was statistical significant difference between the means of pre-test (N = 71, M = 31.1) and post-test (N = 71, M

= 59.5) results after they had been subjected to a paired two-sample t-test analysis (SD 2.5, t(70) = 13.9 p 0.001) with an effect size of 2.68 (Wu et al., 2001).

2.6 Teachers' Factors that Affect Academic Performance

The teacher's beliefs on the academic performance of students

Developmental and educational theorists have discussed the value of child development knowledge base for the teachers throughout the past century. This unfortunately centered on the behaviorist tradition (Brown, 1994) or on extreme biological views such as entity ideas that intelligence is fixed on maturationist view that, children develop on their own. In recent time's psychologist drop such beliefs and practices, and rather endorsed educational practices based on knowledge about how children develop and learn (Brown, 1994).

Different groups of psychologist called constructivist, social constructivist and ecological theories have shifted the attention to child-centered practice or learner centered approach. Even though some people believed that the differences between these theories are not reconcilable, others see them to be complementary (Cobb, 1994). One important trend in these theories is that effective teaching must be based on understanding of the child and the vision of the children as active agents in their own education.

John Dewey who provided the foundation for constructivism believed that teachers must balance an understanding of the habits, traits and dispositions of individual children with understanding of means for arousing children's curiosity (Sisk,1982). Dewey also believed that, fostering mental growth among children requires teachers who can initiate, recognize, maintain and assess children's inner engagement in the subject matter. The teacher is also concerned with how the child's past and present experiences can be related to the subject matter so that they may properly direct children's mental growth.

A social constructivist (Vygotsky, 1978), also share the similar view with Dewey. For him, child development and education were inextricably bound together. He used the zone of proximal development to describe a process whereby the teacher who understands children's development can recognize the "buds" of conceptual or skill development as a prelude to guiding the child from a nascent to a more mature form of understanding or skill.

Among other Psychologists, Jean Piaget also believed that basic ideas are relevant to the argument that teachers need to understand child development and are especially important, given the current drive for schools to foster higher order reasoning and create autonomous learners who are able to function successfully in the rapidly changing information age. Piaget mentioned the following to be reasons why a teacher must be able to understand his or her students.

a) Children's and adults' reasoning differs qualitatively.
b) Knowledge is constructed by engaging actively with the physical and social world.
c) Abstract thinking is built on concrete experience and
d) Conceptual change occurs through assimilation and accommodation.

So as a result of these points, Piaget believed that teachers need to design environments and interact with children to encourage invention, creative, critical thinkers. All these can only be achieved if only the teacher understands the child and his or her basic needs. He therefore put it that the task of the teacher is to figure out what the learner already knows and how he reasons in order to ask the right question at the right time so that the learner can build his/her own knowledge. Bronfenbrenner (1979) mentioned the importance of understanding children's behavior and establishing productive programs and policies to promote the development of children and youth. He also pointed out that teachers make many decisions such as 'curriculum and instructional decisions about materials and methods used in the classroom' that can be informed by understanding of the context in which children live. Whatever decision that is taken by the teacher must intern be influenced by understanding how the knowledge, practice and language socialization patterns within children's families and communities contribute children's ability to function in the classroom.

Another school of thought called developmental psychologist during the latter part of the 20th century also emphasized that ideas about how children learn have enormous implications for teacher education. Studies of problem-solving suggest that teachers need to understand how children approach and solve specific types of problems within content areas and how the development of domain-specific reasoning is linked to "everyday" reasoning (Fish, 1980). In all these theories, there is one thing that is common, that is "a teacher must know in and out of his/her student".

2.7 Difficulties Students face in Understanding Organic Chemistry as Result of English Language Barrier

Even though, chemistry is an abstract course and teachers are looking for ways to make it real and practicable for the learners, there are many other obstacles for most learners which inhibit true concept formation. Among these inhibitors is a second language learner. Concept attainment and language development are inextricably linked (Henderson, 1998). Thought requires language and language also requires thought (Wellinton, 2001). Explained from Vygotskyian point of view, when a learner uses words, he or she is helped to develop concepts. Language thus acts as a psychological tool that help a learner to form thought as well as a proper mental functioning. Children try to make sense from what they were taught by trying to fit it in their own experiences. Thus the child socio-cultural background and linguistic tools available to him or her plays a significant role in concept development. Wellington and Osborne stress in Science Education that research finding s indicated that language in all its forms matters to science education. It is not the language itself but what rather the educators do with the language (Wellinton, 2001). Every language contained several words of which each of them is a 'concept'. But unfortunately scientific concepts can fully be express when words are joined in a sentence (Gordon & Kim, 1972).

2.8 Molecular Model Kits

A molecular model kit is a physical model that represents molecules and their processes. Molecular model kits most at times refer to systems containing more than one atom and where nuclear structure is neglected. These kits are designed to make organic chemistry attractive. These kits are represented by a ball and stick, where the ball represents an element and the stick represents a bond. The balls come in difference colors which represent a specific element. The electronic structure is often also omitted or represented in a highly simplified way. August Wilhelm von Hofmann is credited with the first physical molecular model kit around 1860. Physical models of atomistic systems have played an important role in understanding chemistry and generating and testing hypotheses. There are several motivations for creating physical molecular models.

Molecular Model kits serve as

- pedagogical tools for students or those unfamiliar with atomistic structures.
- objects to generate or test theories.
- analogue computers (e.g. For measuring distances and angles in flexible systems).
- aesthetically pleasing object on the boundary of art and science.

The construction of physical models is often a creative act and many are bespoke. Most have been carefully created in the workshops of science departments. Though molecular graphics has replaced some functions of physical molecular models, the physical kits continue to be very popular and are solid in large numbers. There unique strengths of the molecular models include:

- Cheapness and portability.
- Immediate tactile and visual messages.
- Easy interactivity for many processes (e.g. Conformational analysis and pseudo rotation).

In the 1600s, Johannes Kepler speculated on the symmetry of snowflakes and also on the close packing of spherical objects such as fruit. This problem remained unsolved until very recently. The symmetrical arrangement of closely packed spheres in form theories of molecular structure in the late 1800s and many theories of crystallography and solid state inorganic compounds used collection of equal and unequal spheres to simulate packing and predict structure (Wooster,1945). These are some examples of molecular models. The black colors represent carbon atom in the first three examples.

Other colors could be used to represent anything depending upon what the instructor want.

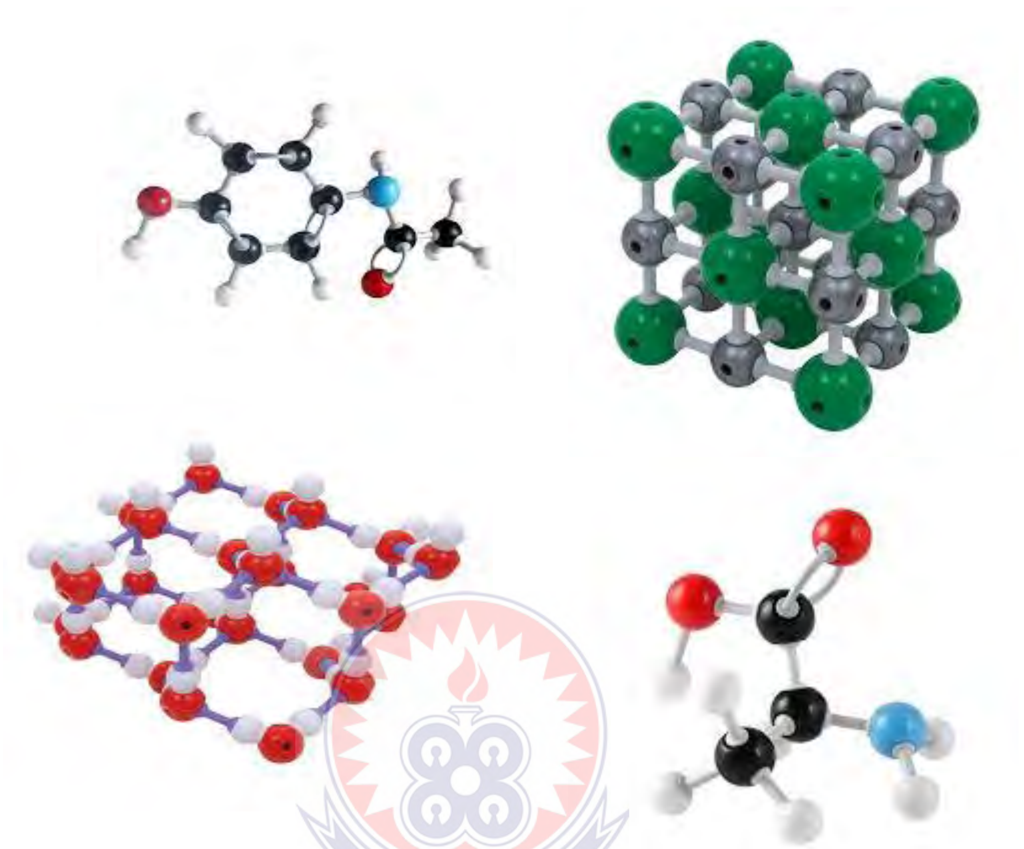


Figure 2.1: Display of the molecular model kits

2.9 Summary of Reviewed Literature

This chapter is made up of conceptual review and empirical review. In the conceptual review, concepts reviewed included: organic compounds and its classification, IUPAC Nomenclature of organic compounds. Among the conceptual reviews were factors influencing the academic performance of students based on the different authors 'perspectives. These factors included influence from parents, teachers, time allocation for chemistry. There are also strategies of improving the learning of organic compounds which involved the use of the molecular model kits and others. Empirical studies were also reviewed across countries based on the objectives of the study. These objectives included; the attitude of students towards the naming and writing of structural formula of hydrocarbons and how effective is the use of molecular model kits in improving students' performance in naming and writing of the structural formula of hydrocarbons.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter deals with the methodology that was adopted for the study.it discusses the research approach, research design, the study population, sampling procedure, the research instrument, data collection procedure and analysis and ethical considerations.

3.1 Research Approach

Research approaches are plans and the procedures for research that span the steps from broad assumptions to detailed methods of data collection, analysis, and interpretation. Cresswell (2007) asserted the importance of illustrating the research approach as an effective strategy to increase the validity of social research. There are three research approaches, namely: (a) qualitative, (b) quantitative, and (c) mixed methods. This study employs the qualitative research approach. Quantitative research is formal, objective, rigorous, deductive approach, and systematic strategies for generating and refining knowledge to problem solving (Burns & Grove, 2005). The four types of quantitative research, namely: Descriptive Research Design, Survey Research, Correlational Research Design, Quasi-experimental Research Design, and Experimental Research Design

3.2 Research Design

The research design used in the study was a Quasi- experimental research. It is a systematic and scientific approach in which the researcher manipulates one or more variables and controls, measures any change in the other variables.

The Quasi-experimental research helps us to confirm why there is a difference in two or more methods of doing things and so doing improve our lives. The choice of this design was necessary as it can be applicable in all settings where problem solving involves people, tasks and procedures that are yearning for solutions.

This design is not the usual thinking that of teachers but a more systematic and collaborative way of obtaining data based on reflection; and further not a research conducted on other people but conducted by particular people on their work in order to improve their own work (Cohen et al., 2007).

The Quasi- experimental design further encourages more positive attitude towards work and continuous professional development in the areas of instruction and content. The study used both quantitative and qualitative methods to collect and analyze data respectively from test, observations, and conservations with students to justify how effective the molecular model kits are effective in enhancing students' performance in naming and writing of structural formulae of hydrocarbons.

3.3 Population

Winneba Senior School is a mixed school in the Central Region of Ghana which runs 6 courses which are General Science, General Arts, Business, Home Economics, Agricultural Science and Visual Arts with a total of about two thousand seven hundred and eighty-two (2782) students which comprises 54.8% males and 46.2% females. However, for the purpose of this study, the target population was all SHS 3 science students with a total number of two hundred and forty (240) as the concept of IUPAC nomenclature of organic compounds is taught at this level in Chemistry. Also, at the time of the study, it was found that the third year science students were yet to learn IUPAC nomenclature under Chemistry.

3.4 Sample and Sampling Technique

Since it is virtually impossible to undertake the study with all the students, therefore a sample size of forty- four (44) students was used for the study. This was derived from using the sample size determination technique by Krejcie and Morgan (1970). Simple random sampling was used to select respondents from each class. The aim of using simple random sampling was to give equal chances to part of the whole chemistry student population to respond to the questions.

Using this technique, pieces of paper were used for balloting with either "Yes" or "No" written on them, it was folded and put in a container and allowed students who offer chemistry to pick one piece of paper. The number of "Yes" corresponds to the number of students needed in each class. The inscription on the paper picked is noted. Any student who picked "Yes" was selected to participate in the study.

3.5 Research Instruments

The main instrument for the study was achievement test interspersed with questionnaire and interviews. The achievement test was made up of pretest and posttest which were items constructed by the researcher. The test items were then compared to standardized test items used by the West African Examination Council (WAEC) for assessing high school students' knowledge in Chemistry.

The interviews, which took the form of conversations with some students and the researcher with some students helped to ascertain students' conceptual development and interest in the lesson throughout the period of the study. A conversational type of interview was adopted to prevent the researcher and the students from adapting defensive mechanisms in responding to issues we intended to probe. It helped a lot as the students felt free and natural in interacting with the researcher.

Questionnaire was also used in the collection of the data for the study since it affords a greater assurance of anonymity and confidentiality. The instrument was developed by the researcher himself.

The questionnaire was made up of four main sections. Section A was made up of the background characteristics of respondents specifically sex, age, and class, section B related to instructional strategies used in teaching students. There were three (3) questions and the respondents were asked to rate on the uses of instructional strategies by their teachers during a lesson using a Likert scale with a rating of 3 for ‘often’, 2 as ‘sometimes’, 1 for ‘rarely’, and 0 for ‘never’. Section C was based on perceptions about the uses of instructional strategies and the final section looked at the students’ perceptions of the effects of instructional strategies on their academic performance. The questionnaire contained scale-type items and close-ended questions.

3.6 Validity of the Instrument

To ensure the validity of the instrument, it was tested through construct validity, face validity, and content validity. With face validity, the instrument was developed based on literature, focusing on the main findings of previous studies. Content validity measured the degree to which the sample of the test represents the content that the test is designed to measure (Orodho, 2012). This assisted in establishing whether the questionnaires measured what they were supposed to measure. Face and content validity were determined through inspection by the supervisor.

3.6 Reliability of the Instrument

The reliability of a research study looks at the degree to which the research methods produce stable and consistent results. It is about how another researcher produces the same findings, using the same tools and methods that were employed by the previous researchers. Reliability gives us the accuracy of what we measure Strauss & Smith (2009), that is, how well our methods are measuring what we intend to. According to Bryman and Cramer (2006), the reliability of a research instrument measures its stability and consistency. To ensure the high reliability of this study, there was a thorough description of the procedure for the study, therefore all the data and information gathered were described in detail throughout this report. Again, the use of a good research instrument was likely to increase the reliability.

3.7 Data Collection Procedure

Before the data collection, an introductory letter was obtained from the Department of Educational Foundations, University of Education Winneba, and was sent to the head of Winneba Secondary School for permission to carry out the study. The data was collected by the researcher himself with the assistance of two other teachers. Sampled students in each class were assembled for the researcher to explain the purpose of the study. After this, the consent of the students was sought by ticking either 'Yes' or 'No' on a consent form. Those who ticked 'Yes' were given the questionnaire to fill out. Some of the students did not understand some of the questions, the researcher patiently and audibly read out one after the other, every item on the instrument, and gave explanations, where necessary. After filling, the questionnaires were collected on the spot.

3.8 Ethical Considerations

According to Berg and Lune (2016), ethical issues are concerned with "issues of harm, consent privacy and data confidentiality". It is therefore imperative for a researcher to have an ethical consideration for the study population. Permission letter is sought from the department gain to assess respondents has clearly defined the purpose of the study would be purely academic, that the privacy of the participants would be protected, and the study would not in any manner disrupt regular activities in the school. To minimize any suspicions on the part of the participants, the letters clearly indicated that the findings would not be used for political purposes. The findings would be beneficial to the school and by extension, improvement in the general performance of students in organic compounds.

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION OF RESULTS

4.0 Overview

In this chapter the researcher presents the analysis of the research data obtained from the participants of the study. The chapter discusses the results (findings) of the pre-test and the posttest. The data were organized and presented using tables, figures and descriptive statistics. Furthermore, the results of the pretest and the posttest were compared from the SPSS analysis using the paired sample *t* test.

4.1 Presentation of Results

The results of the study obtained by the students were analyzed and discussed in relation to the objectives of the study. Scores on pre-test and post-test were taken for analysis to identify student's difficulty in naming and writing organic compounds and to ascertain the effectiveness of the intervention process respectively.

4.1.1 Pre-test

The pre – test (see Appendix A) was aimed at finding out the students' difficulties in naming and writing organic compounds. A total of five (5) questions which were marked out of fifteen (15) and was conducted for forty- four (44) students. Table 1 below shows the frequency distribution in percentages of the scores obtained by the students in the pre – test conducted.

Table 4.1: Frequency distribution of pre –test scores in percentages

Scores	Frequency	Percentages (%)
0 – 1	12	27.27
2 – 3	14	31.82
4 – 5	5	11.36
6 – 7	8	18.18
8 – 9	1	2.27
10 – 11	3	6.82
12 – 13	1	2.27
14 – 15	0	0
Total	**44**	**100**

Table 4.1 above clearly shows a generally low performance in the test conducted as 39 out of the 44 students that took the test representing 88.63% scored below half the total marks in the test. More so, out of this number that scored below half the marks, 27 which is 69.23% (61.36% of the class) scored between 0 and 3 out of the total scored of 15. This clearly indicates that more than half of the students score as low as 25% or less in the test conducted. The histogram in fig. 4.1 below further shows clearly the distribution of student's scores in the pre – test conducted. It can be seen clearly in the histogram below that, the scores as gathered from the pre - test conducted is positively skewed as majority of the data values cluster at the low end of the distribution.

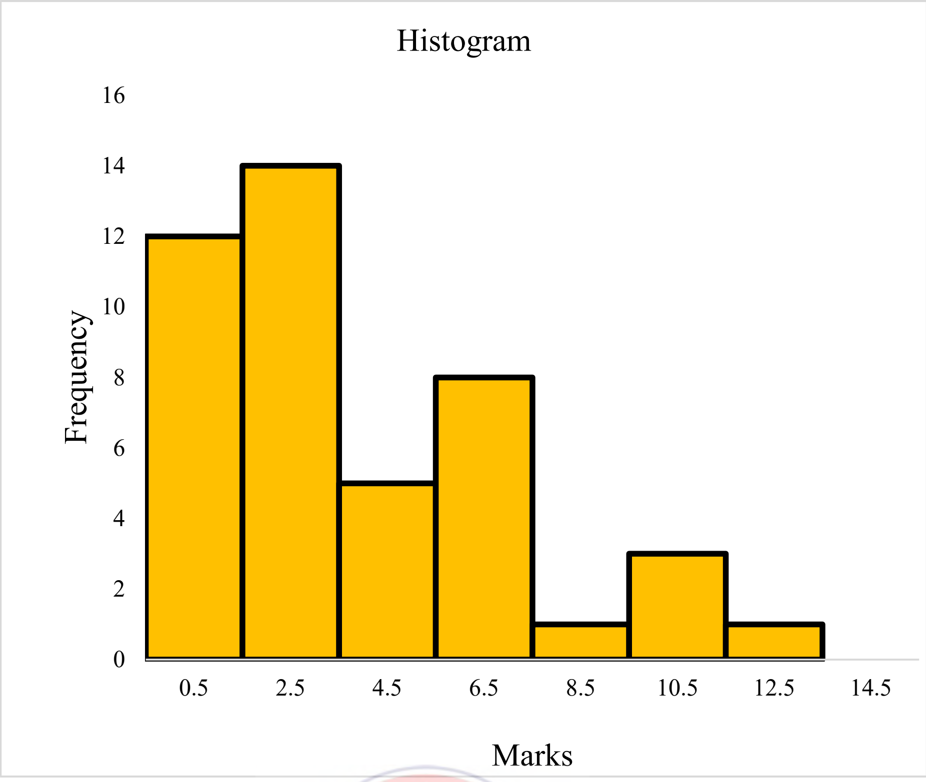


Figure 4.1: Histogram of pre- test scores

4.1.2 Post -test

After administering the pre – test and observing a generally low performance of the students in naming and writing the structures of organic compounds, a series of activities were undertaken including the use of the molecular model kits as an intervention to address the students' difficulties in naming and writing the structures of organic compounds, after which a post – test was administered to them. This was aimed at ascertaining whether the intervention had gone down well with the students or not.

The post–test, involving five (5) questions (see Appendix B), required the students to name and write the structures of organic compounds of different forms was also administered to the 44 students of the class under similar conditions as the pre - test and scored out of fifteen (15). Table 4.2 below is the frequency distribution in percentages of the marks obtained by the students in the post – test.

Table 4.2: Frequency distribution of post–test scores in percentage

Scores	Frequency	Percentages (%)
0 – 1	0	0.00
2 – 3	2	4.55
4 – 5	4	9.09
6 – 7	6	13.64
8 – 9	9	20.45
10 – 11	9	20.45
12 – 13	11	25.00
14 - 15	3	6.81
Total	**44**	**100**

The post – test scores indicated a change in the performance of the students as compared to that of the pre –test scores as shown in table 4.2 above. The frequency distribution table on the post scores in Table 4.2 above clearly shows an improvement in the general performance of students as 32 out of the 44 student who took the test representing 72.73% scored 8 and above with only 2 students scoring between 0 and 3 representing 4.55%. This indicates clearly that majority of the students' scores in the post test are clustered at the upper end of the distribution there by given a negatively skewed as shown in fig. 4.2.

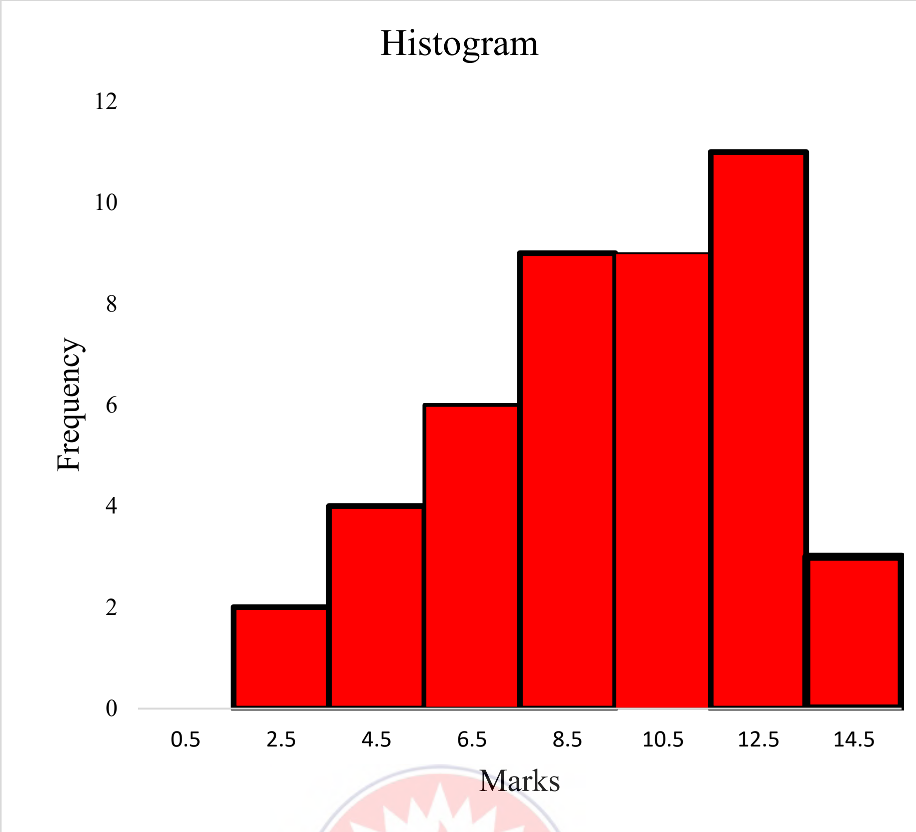


Figure 4.2: Histogram of post–test scores

The researcher attributed the improvement in the students' performance to the teaching strategy employed in the intervention. With the use of the molecular model kits, the students were actively engaged to come out with the names and structures of some organic compounds.

The researcher undertook inferential analysis of the pre – test and post – test, and the data used for this analysis were the scores obtained by the students in both tests. Statistical Package for Social Scientist (SPSS) was employed by the researcher to obtain the results of the analysis as shown in table 4.3 below.

Table 4.3: Descriptive statistics of pre – test and post – test scores

	Mean	N	Std. Deviation	Std. Error Mean
Pre-test	3.7727	44	3.24835	.48971
Post-test	9.5455	44	3.29520	.49677

Results from Table 4.3 indicate that, the mean value of the pre – test scores and the post – test scores were 3.7727and 9.5455 respectively. The standard deviation of the pre – test scores was also 3.24835 whiles that of the post – test was 3.29520.

Comparatively, a conclusion can be drawn from the mean score values of both the pre – test scores and the post – test scores. The mean scores showed a significant improvement in students' performance in naming and writing the structure of organic compounds. The intervention process using the molecular model kits has helped the students in solving problems related to naming and writing the structure of organic compounds.

4.2 Testing of Hypothesis

The means of the two samples, the pre–test and the post–test was compared to see whether there is a significant difference between them. Since the same subjects were used in both cases, the researcher employed the paired sample t-test at a confidence interval of 95%. The results obtained from the analysis of the dependent samples, pre–test and post–test using SPSS, are given in Table 4.4 below.

Null hypothesis, H_0

There is no significant difference in the mean scores of the pre–test and the post–test of the students at α = 0.05 level of significance.

$$H_0 : \mu_D = 0$$

Alternate Hypothesis, H_α

There is significant difference in the mean scores of the pre–test and the post–test of the students at α = 0.05 level of significance.

$$H_\alpha : \mu_D \neq 0$$

Table 4.4: Paired sampled test for pre-test and post-test scores

		Mean	Std. Deviation	Std. Error Mean	95%Confidence Interval of the Difference		t	Df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	pretest – posttest	-5.7727	2.95598	.44563	-6.67143	-4.87403	-12.954	4, 3	.000

From table 4.4 above mean of the difference between the pre-test scores and the post test scores ($\overline{D}$) is -5.77273, the standard deviation of the difference (S_D) is 2.95598, and the 95% confidence interval of the difference is -6.67143 < μ_D < -4.8740. The test value or test statistic computed is -12.954 with a P value (significant value) of 0.00.

Since the P-value of 0.000 is less than the chosen alpha-level (0.05), we reject the null hypothesis that states that there is no statistically significant difference between the means of the pre-test and post-test. There is therefore enough evidence to conclude that the use of the molecular model kits has helped improved the performance of students in Winneba Senior High School in naming and writing the structure of organic compounds especially hydrocarbons.

Since the test statistic (-12.954) is not contained in the confidence interval of the difference, the decision is to reject the null hypothesis and accordingly accept the Alternate Hypothesis.

It is therefore concluded that there is a significant difference between the pre – test scores and that of the post – test which is in favor of the post – test since the mean of the difference is less than 0. And this is attributed to the intervention processes the researcher took the students through.

4.3 Discussion of Results

The results obtained from analyzing the data collected from the student's pre – test and post– test scores as presented above were discussed based on the research questions of the study to ascertain if they undoubtedly answer the research questions.

The findings in the study showed that the students were not able to use the appropriate prefix for the naming of the organic compounds. With some who were able to use the appropriate prefix, they also forgot to use the right substituent. Some students were unable to identify the position of two or more substituents on a compound. These and many others accounted for their scores in the pre – test. The pre–test was basically aimed at finding out the students' difficulties in naming and writing the structure of organic compounds. The results from Table 4.1 showed that 88.64% of the students scored less than half of the 15 marks for the test. This shows that the students performed below average.

- ❖ The first research question read: What is the attitude of students towards naming and writing of structural formulae of hydrocarbons?

In agreement, Njoroge and Orodho (2014) examined the senior high school students' attitude towards chemistry in public secondary schools in Nairobi Country and reported positive perception and attitude among students towards naming and writing of structures organic compounds. These findings corroborate with the findings of this current findings since positive attitudes have been reported in both studies. The improvement in the performance of the students, which was evident in the post – test scores they obtained, was not by chance, but through the use of the molecular model kits employed by the researcher during the intervention activities. Through the use of the molecular model kits, the students were able to create their own understanding of the concepts and come out with solutions to given problems with the researcher only serving as a guide and creating the necessary environment needed for effective learning. Through this, students were motivated and also inspired by the way the lessons were taught.

- The second research question read: How effective is the molecular model kits in addressing students' difficulties in naming and writing the structures of organic compounds especially hydrocarbons.

The findings in the study clearly indicates that the use of the molecular model kits in teaching naming and writing the structures of organic compounds especially hydrocarbons had a positive effect on the performance of the students.

Results from the post – test scores by the students, as shown in Table 4.2, clearly indicated that the students performed much better as compared to the pre–test (table4.1). This suggests that they had improved upon their ability to name and write the structures of organic compounds of any form. From the frequency distribution of the post – test scores (Table 4.2), out the forty - four (44) students who took part in the test, thirty – two (32) of them obtained more than half of the total mark of 15 for the test, representing 72.73% of the total students' number. The results indicated an upward trend in the post – test scores, which showed that the intervention activities were effective in assisting the students overcome their problems and helping them in their learning. This stands to agree to the fact that the use of manipulative materials (the molecular model kits) in teaching and learning process makes students more engaged in a lesson and guide students in a way of representing their thinking (Naiser,Wright & Caproro, 2004). Amoakohene (2013) also argued that teaching with the use of the manipulative material serves as a motivation in the teaching and learning situation.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Overview

This chapter summarizes the research findings and conclusions. It also presents recommendations for further research works and curriculum development.

5.1 Summary of Research Findings

The research was conducted to address the difficulties of students naming and writing the structures of organic compounds of SHS 3 Science students of Winneba Secondary School. The aim was to use molecular model kits to help students in their understanding of naming and writing organic compounds. So, in all, 44 students from form 3 Science class were involved. A pre-test consists of 5 questions were given to students which were intended to determine the performance of students and to identify their problems in naming organic compounds. The researcher used molecular model kits to assist students alleviate their problems. The following research questions assisted the researchers:

1. What is the attitude of students towards naming and writing of structural formulae of hydrocarbons?
2. How effective is the use of molecular model kits in improving students' performance in naming and writing of structural formulae of hydrocarbons?

The pre-test and post-test were analyzed using tables and both descriptive and paired differences. The intervention led students develop more positive attitude towards chemistry as a discipline because they were more excited as they could now find solutions to a more challenging problems in chemistry and reach conclusions. Other factors gathered from the findings that need to be noted are that teacher's systematic presentation of various strategies for naming and writing organic compounds to students help improve the students' participation.

In addition, molecular kits as a model for teaching organic compounds is simple to produce and handle. Unlike other materials that are time consuming and non-economical, our intervention material can be made within the shortest time and is economical. This model is also user friendly and this helps facilitates the understanding of naming organic chemistry.

5.2 Conclusions

The purpose of the study was to use molecular model kits to remedy the problem of naming and writing of organic compounds of Winneba Secondary School students of SHS 3 Science students. After the intervention it was found out that all the students performed above average which signifies that the students' difficulties in naming and writing of organic have been addressed with significant improvement in their skills in naming organic compounds and other related problems.

In a world where technology is far much advancing, chemistry teachers should vary their teaching methods and strategies in order to meet the needs of the needs and also make them fit into the society.

On this note, the researcher therefore hold the view and conclude that, the use of manipulative materials in the teaching and learning of chemistry help students get better understanding of the concepts, apply concepts in real life situations and also arouses students' interest for the learning of chemistry.

5.3 Recommendation

The study takes a look at the benefits for the use of the molecular model kits in teaching and learning of organic chemistry. Based on the result of this study, the researcher made these recommendations for the improvement of students' performance, teachers' methodology, curriculum developers and policy makers.

- Molecular model kits should be made available in our schools for students to use.
- Facilitators should encourage students to use the molecular model kits in solving problems involving naming and writing of organic compounds especially naming of hydrocarbons in class instead of using rule approach (traditional learning approach).
- Curriculum developers and policy makers (stake holders) in education should emphasize the use of the molecular model kits as a core procedure for teaching in chemistry classroom.

5.4 Suggestions for Further Study

For the purpose of improvement in this area, this study makes the following future research:

- In future, a study like this should extend and cover more schools and increase the population and sample as well.
- Many pre-test and post-test should be conducted. More tests being administered to students enhances the validity of the findings and generalizations.
- In the interest of all, educational programmes, workshops and seminars and the use of molecular model kits strategies should be organized for teachers on

how to use them effectively in their daily teaching in chemistry classroom. These will need some sort of financial support and the government and other donor agencies should support these programmes for their proper implementation.

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APPENDICES

APPENDIX A

Pretest on IUPAC Nomenclature of Organic Compounds

Dear Head,

These tests is meant to collect data for a study being conducted by Martin Kwesi Beyamfui a student from University of Education, Winneba in connection with a Postgraduate Diploma dissertation title ‘Effect of Molecular Model Kits on naming Organic compounds in Chemistry amongst Winneba Senior School Students’. The information provide will help teachers find a better way to teach naming of organic compounds. You are assured that the information you provide will be given the utmost confident in addition to non-disclosure of your identity should data be published. Taking part in this study is however voluntary.

Thank you.

Biographic Data

Gender: Male [ ] Female [ ] Age [ ]

Name of School: …………………………………………………………….

This pretest seeks to find out your understanding of IUPAC nomenclature of organic compounds. Please provide the responses in the spaces provided. Your performance will be used for research purposes only and will be highly confidential. You are therefore to respond to the items to the best of your ability. Use 40 minutes to respond to the items after which your paper will be collected. Each answer to a sub-question attracts 1 mark

INSTRUCTION: Consider the following organic compounds and use them to answer Question 1 to 5

A. $CH_3C(CH_3)_2CH_2CH_2CH_3$

B. $CH_3C(Br)_2CHCHCH_3$

C. $CH_3CH_2CCHBrCH_2Cl$

1. Indicate below the longest continuous carbon chain and the parent name in each of the above organic compounds labeled A, B and C above in the table below.

Compound	Longest continuous carbon chain	Parent Name
A		
B		
C		

2. Indicate below the name of the substituent and their respective positions in each of the Organic compound labeled A, B and C above in the table below.

Compound	Substituent/s	Position of substituent
A		
B		
C		

3. Name the functional groups present and their respective positions in each of the organic molecules labeled A, B and C above in the table below.

Compound	Functional Group	Position of the Functional Group
A		
B		
C		

4. Draw below the structural formula for the condense formula for each of the hydrocarbon compounds labeled A, B and C above in the table below.

Compound	Structural Formulae
A	

B	
C	

5. Name each of the above compounds labeled A, B and C in the table below

Compound	IUPAC NAME
A	
B	
C	

APPENDIX B

Posttest on IUPAC Nomenclature of Organic Compounds

Biographic Data

Gender: Male [ ] Female [ ] Age [ ]

Name of School: ……………………………………………………….

This posttest seeks to find out your understanding of the IUPAC nomenclature of organic compounds. Please provide the responses in the spaces provided. Your performance will be used for research purposes only and will be highly confidential. You are therefore to respond to the items to the best of your ability. Use 40 minutes to respond to the items after which your paper will be collected. Each answer to a sub-question attracts 1mark

INSTUCTION: Consider the following organic compounds and use them to answer Question 1 to 5

A. $CH_2CH_2CHBrCH_2CH_2CH_2CH_3$

B. $CH_2ClCH_2CH_2CHCH_2$

C. CH_2ICH_2CH2C(Cl)2CHCH3

D. $CH_3C(CH_3)_2C(Br)_2CHCH_2$

1. Indicate below the longest continuous carbon chain and the parent name in each of the above organic compounds labeled A, B, C and D

Compound	Write the Longest Carbon Chain	Give the Parent Name
A		
B		
C		
D		

2. Indicate below the name of the substituent and their respective positions in each of the organic compounds labeled A, B, C and D above.

Compound	Name Of Substituent	Position of the Substituent
A		
B		
C		
D		

3. Name the functional groups present and their respective positions in each of the organic molecules labeled A, B, C and D above in the table below.

Compound	Functional Group	Position of the Functional Group
A		
B		
C		
D		

4. Draw below the structural formula for the condense formula for each of the hydrocarbon compounds labeled A, B, C and D above.

Compound	Structural Formulae
A	
B	
C	
D	

5. Name each of the above compounds labeled A, B, C and D in the table below.

Compound	IUPAC NAME
A	
B	
C	
D	

APPENDIX C

Introduction Letter

UNIVERSITY OF EDUCATION, WINNEBA
FACULTY OF EDUCATIONAL STUDIES
DEPARTMENT OF EDUCATIONAL FOUNDATIONS
P. O. Box 25, Winneba, Ghana
020 298 0085

16[th] February, 2022.

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

LETTER OF INTRODUCTION

I write to introduce to you, MARTIN KWESI BEYAMFUI, the bearer of this letter who is a student in the Department of Educational Foundations of the University of Education, Winneba. He is reading POST GRADUATE DIPLOMA IN EDUCATION with index number 200049628.

He is conducting a research on the topic: EFFECT OF MOLECULAR MODEL KITS ON NAMING ORGANIC COMPOUNDS IN CHEMISTRY AMONGST WINNEBA SENIOR SCHOOL STUDENTS. This is in partial fulfillment of the requirements for the award of the above mentioned degree.

He is required to gather data through observation for the said research and he has chosen to do so in your outfit.

I will be grateful if he is given permission to carry out this exercise.

Thank you.

Yours faithfully,

DR. RICHARDSON ADDAI-MUNUNKUM
AG. HEAD OF DEPARTMENT

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