

# Effects of Computer Aided Vee-Mapping Strategy on Senior Secondary School Students' Learning Outcome in Organic Chemistry in Niger State, Nigeria

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## Abstract

The study investigated the effects of Computer Aided Vee-Mapping Strategy and conventional teaching method on Senior Secondary School Students' Learning Outcome in Organic Chemistry in Niger State, Nigeria. The study answered two research questions and tested two null hypotheses and adopted quasi-experimental research design. Two secondary schools were selected and designated as Experimental Group and control with a sample size of 103 (53 and 50). Reliability coefficient of 0.86 was obtained when Organic Chemistry Interest Inventory was administered on few students of equivalent level in the pilot study. The data obtained were analysed to answer the questions using mean and standard deviation while the hypotheses were tested using independent t-test in Statistical Package for Social Sciences (SPSS) Version 23. The findings revealed that students taught using Computer Aided Vee-Mapping Strategy had higher interest in Organic Chemistry better than those taught using conventional teaching method; also, male students had higher interest level in Organic Chemistry than the female students with Computer Aided Vee-Mapping Strategy. Based on the findings, it was recommended that Computer Aided Vee-Mapping Strategy should be used for teaching and learning processes in Chemistry in Nigerian schools.

**Keywords:** Chemistry education, Learning outcomes, Secondary school, Science students, Vee-mapping strategy



## Background to the Study

Chemistry has been identified as a very important science subject and its importance in scientific and technological development of any nation has been widely reported (Ava, 2012). It was as a result of this recognition given to Chemistry in the development of individual and the nation that has made it a central science and branch of pure sciences that deals with composition of matter and the principle (Agogo and Otor, 2013). It has been a pre-requisite subject for offering science oriented courses in the tertiary institution. Chemistry knowledge provides students with valuable concepts, life skills and career options which help to give learners greater appreciation for environment in which they live, problem-solving and research skills.

Chemistry education contributes to societal development by helping students to develop into more responsible citizens who would help to build a strong economy, society, healthier environment and thus, bringing about a brighter future (KIE, 2015). Aksela (2012) has earlier asserted that knowledge of chemistry has made a lot of contribution to the development of the nation and welfare of mankind in various fields. Examples of these contributions are in the industrial sector especially in beer brewing, mining, milk processing, bread making as well as waste disposal processes. Chemistry knowledge has also made it possible for disease control and treatment of various ailments in the society.

Chemistry education is therefore the systematic process of acquiring the fundamental knowledge about the universe. With this indispensable knowledge richly acquired, man can shape and reshape his world for his benefit. Hence, the development of the nation is usually measured by the degree and extent of growth brought to it through the enterprise of science education and a gate way to it is Chemistry education. Chemistry education plays important role in enhancing the quality of teaching and research as well as ensuring that students are equipped with good knowledge to produce intensive good and services to meet human needs for food, health care products and other materials aimed at improving the quality of life. Every single material thing in the universe is a chemical and the ability to understand and manipulate these chemicals is responsible for everything from modern food and drugs to plastics and computer. Chemistry education is needed in the chemical industries and required in the establishment of modern technology and operation of chemical industries (Mohammed, 2014).

The goal of chemistry education is to guide students in building mental models of chemical phenomena and enclose congruence to scientifically accepted models, as the higher-order thinking skills are unfolded as challenges. One area of chemistry where students demonstrate a lot of challenges with respect to building authentic mental models is Organic Chemistry (Hanson and Acuah, 2014). Adequate understanding of Organic Chemistry is a pre-requisite for many graduate and professional programmes in human care. It is a key to the development of new products in the society and for improving on many more of them that we have become dependent on. It is the basis for the production of food flavours, plastics, clothing, car types, fuels, cement, pharmaceuticals and house cleaning agents. It is also important in the investigation and security agencies (Aksela, 2012).



Students consider Organic Chemistry as a big hindrance to the study of Chemistry as a discipline. Several factors affect students' performance (Coll, 2014). Some of these have been known to include their own preparedness, teachers content knowledge, environment and social factors; including the home and school, language and many more (Korau, 2014). In-depth studies into the poor performances by educational researchers and the West African Examinations Council (WAEC) have been traced to several factors. One of them is their inability to answer questions based on organic chemistry in particular coherently and from a conceptual basis (Hanson, 2017; WAEC, 2015), and some do not attempt to answer such questions at all and some make feasible attempts. One major cause that was recently identified as an underlying reason for student's poor performance in organic chemistry is their inability to connect the molecules within organic compounds coherently to form a mental model (Gilbert and Ferreira, 2014).

More often, poor performance is blamed on students because of their low retention capabilities, low interest level, low achievement, inappropriate social groups in school and parental issues. Nevertheless, other factors such as teachers themselves also play a significant role during the teaching and learning process as to influence students' interest towards the study of Chemistry Especially Organic Chemistry and any positive influence of the teacher can affect students' achievement positively (Yara, 2011). Thus, more interactive and engaging environments where enthusiastic teachers facilitate and do not bear too much on students' constructive activities could enable students to feel free while they take responsibilities for their actions and learn to construct their own informed knowledge.

Another factor identified as cause of students' poor performance in Chemistry in general and Organic Chemistry in particular is teaching approach that is employed by most teachers. Most teachers employ the lecture or traditional method. In the traditional teaching approach, which is common, students are passive recipients while in active learning approaches such as Vee-mapping strategy students assume active position, as they learn tasks that require their involvement and stimulate learning.

Students' own interest is also another factor that affects the performance in their study of organic Chemistry. In Chemistry education, interest as part of learning outcomes is an important factor that affects student's achievement. Furo (2015), defined interest as a social construct developed within the dynamic relationship between an individual and the situation. Students' interest in learning is linked with their anxiety to learn. It consists of feelings and tendencies towards a concrete matter. A characteristic feature of interest is a manifestation of different preference toward actions, events or plans. A student's interest in academic achievement will induce him to behave and act in a certain way toward his studies (Ogbuaya and Owodunni, 2013). Interestingly from some quarters, Vee-Mapping is acclaimed to enhance interest of students towards learning.

Vee-mapping is such a teaching approach where students use V-shape to represent key elements (ideas) that are contained in the structure of knowledge. The key elements usually referred to as the vee-heuristics forms the point of focus in knowledge creation in the objects



or events that learners observe (Godwin, 1997). The vee-map has two sides. The left hand side represents the theory and is referred to as the conceptual side. It outlines the philosophy, theories, principles and concepts that guide learners in selecting or constructing objects or events to be observed in the learning process especially with the use of computers. Computer provides immediate feedback, letting students know whether answers are correct or not. If the answer is not correct, it shows how the students can get the correct answer. Many researchers have used computer-aided instruction in different subject areas to improve effective teaching and learning. Computer aided vee-diagram instructional strategies will incorporate the use of computer instruction and other ICT tools with computer aided vee-mapping (Anderson-Inma and Zeitz, 2013).

Zubairu, Gambari and Agbor (2017), asserted that the use of computer-based instructional strategy has no significant effects on students' performance in Physics; however, Yusuf and Afolabi (2013) reported from their studies that computer assisted instruction has significant effect on students' performance in science. Similarly, Lou, Wen and Tseng (2013) who investigated the effect of integrating computer aided vee-diagrams into computer assisted instruction in chemistry learning achievement found out that the students in the experimental group who were taught with computer aided vee-diagrams achieved significantly better than those in the control group.

With computer-aided instruction, the knowledge claims are integrated into an individual's cognitive meaning frameworks. Novak (2008) and his team carried out a study on the use of computer aided vee-mapping in learning Biology at high school level. The study was done simultaneously with that of concept diagram. The findings of the study revealed that most students were relatively successful in using the vee-maps and their achievements were improved. This was attributed to the fact that vee-mapping helped the students to sort out events or objects under study, key questions being addressed, major claims derived from the record or transformed records and the consistency between concepts, principles, records, events or objects and the stated claim. Therefore, concept diagram and vee-diagram are tools that would aid pedagogy that derives from recent advances in educational theory (Novak and Godwin, 1983). They are two distinct techniques identified as recent advances/innovations in science education that have been shown to enhance achievement, interest and retention of the learners in some other countries. The two learning strategies, though distinct, have many commonalities.

Learning outcomes in this study will include academic interest. Achievement is the result of secondary school students in Chemistry over a given time especially at the end of academic session (Ganai and Mir, 2013). Olugbodi (2015), sees academic achievement as the measure of students learning or acquisition of certain skills at the end of teaching and learning activities. Based on the importance of academic achievements in school setting, he asserted that academic achievement is the extent of which a person has progressed in something, acquired certain information or mastered certain skill, usually as a result of planned instruction or training. The level of achievement obtained by learners depends largely upon their own needs, expectation, learning, environment and method of teaching. Adeyegbe



(2012) traced the low achievement of students in practical Chemistry to teachers' inability to take the candidates through sessions in laboratory. Interest is the attraction, which compels a child to respond to a particular stimulus.

Interest is a motivating variable which must be sustained in the learners before effective learning is achieved or accomplished. It is the preference for particular types of activities that is, the tendency to seek out and participate in certain activities (Gimba, 2013). A study on the interest towards Biology and its effects on students' achievement was conducted by Nasr and Asgbar (2011) using a total of 185 grade 12 students in Isfahan. The relationship between interest towards Biology and students' achievement in Biology courses at the following dimensions (a) motivating Biology class; (b) self-directing efforts; (c) femininity models; (d) Biology is fun for me and (e) peer models were considered. The result showed that students had interest towards science dimensions only Biology is fun for me, had meaningful and positive relation with students' achievement in Biology.

In a related study, Polacos (2012), compared the effectiveness of the use of vee-diagrams against that of concept maps on interest in Chemistry concepts. The researcher followed a quasi-experimental and non-equivalent comparison group approach. The experiment involved two classes of third-year students of Licio de Cagayan University High School in Cagayan de Oro City during the school year 2009-2010. Before the intervention, two similar tests were prepared, the pretest (PRT) and the posttest (POT) and interest inventory were carried out. Evidently from the result obtained, students developed a rich system of the concepts and their learning interest of Chemistry was improved. The conceptual interconnections helped students formulate theoretical explanations about observed change. Teacher should stimulate students to integrate knowledge from the various scientific discipline to ignite interest and boost achievement, this finding point to the importance of emphasizing connections between concepts in high-school chemistry instruction and computer aided vee-diagram.

In another study by Safdar, Hussaini, Shah and Tesnin (2013), depicted how idea and v-graph help in enhancing the standard of learning in the science research facility. Taking a gender as material science particularly the adequacy and effectiveness of these apparatus was considered and it was discovered that the idea maps and v-chart enhance the execution of the students and make adapting more important in physical science research facilities. Gender in relation to achievement has been an issue of interest and concern to researchers in education. There are varying opinions in which gender (either male or female) achieves better than the other. The issue of gender becomes crucial in this present day because schools in the research are co-educational. Also, the interactive evidence in academic achievement due to gender has necessitated the need to verify how vee-mapping instructional strategy can influence students' achievement and interest in organic chemistry. Therefore, there is need to examine the effects of vee-mapping strategy and conventional teaching method on senior secondary students learning outcomes in Organic Chemistry in Niger State, Nigeria.



### **Statement of the Research Problem**

The performance of students in science generally has been quite unsatisfactory over the years (Olorunkoba, 2016). The external examination bodies such as West African Examination Council (WAEC) and National Examination Council (NECO) have repeatedly reported poor performance in chemistry. The report of the Chief examiner, WAEC (2014-2018) revealed that candidates' performance in chemistry which organic chemistry is part in Niger State were poor. WAEC May/June 2017 with a raw mean score of 36.00 and standard deviation of 15.62 of 667, 412 candidates that sat for the paper is less than the raw mean score of 43.00 and standard deviation of 15.36 of 725,311 chemistry students of May/June, 2015. Furthermore, a critical look at the statistics of candidates' enrolment and performance in chemistry in Niger State for the year 2014-2017 shows that the performance of the candidates was poor. The persistent poor performance, according to chief examiner for the years reviewed was as a result of poor understanding of general principle and concepts of chemistry which organic chemistry is part of (WAEC, 2016).

This poor performance as indicated by the results can be attributed to many factors which include; ineffective teaching methods, unqualified and inexperienced teachers teaching the subject, lack of appropriate and effective use of media among others (WAEC, 2016). The implication therefore is that a large percentage of science students will not be admitted to study science related courses in institutions of higher learning since chemistry is one of the subjects that must be passed at least at credit level in SSCE in order to study science related courses in higher institutions. Despite all that has been done to improve students' achievement especially in chemistry, students still perform poorly as evident in the chief examiner's report of WAEC 2014-2018. Therefore, this study seeks to determine the effects of vee-mapping instructional strategy and conventional teaching method on learning outcomes of students in senior secondary school's year II (SS II) organic chemistry in Niger State, Nigeria.

### **Research Questions**

The study was guided by the following questions.

1. Is there any difference in the mean score of students' interest in Organic Chemistry when taught using Computer Aided Vee-Mapping strategy as against conventional teaching method in Senior Secondary School in Niger State, Nigeria?
2. Are there differences in the mean score of male and female students' interest in Organic Chemistry when taught using Computer Aided Vee-Mapping strategy and those taught using conventional teaching method in Senior Secondary School in Niger State, Nigeria?

### **Research Hypotheses**

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

HO<sub>1</sub>: There is no significant difference in the mean score of students' interest taught Organic Chemistry using Computer Aided Vee-Mapping strategy and those taught using conventional teaching method in senior secondary schools in Niger State, Nigeria.



HO<sub>1</sub>: There is no significant difference in the mean score of male and female students' interest taught Organic Chemistry using Computer Aided Vee-Mapping strategy and those taught using conventional teaching method in senior secondary schools in Niger State, Nigeria.

## **Methodology**

### **Research Design**

The research design adopted for this study is a quasi-experimental research design. It is a pretest, posttest, non-randomized and non-equivalent control group design. Two groups were used for this study which includes Experimental Group and Control Group. There is Vee-Mapping Instructional Strategy using hierarchical and spider modes which was used for the Experimental Group while conventional teaching method was used as the control group. There are two dependent variables which are academic achievement and interest. Gender (male and female) is the moderating variable.

The experimental and control group were administered with Organic Chemistry Achievement Test (OCAT) at pretest to test the level of intervening variables that was responsible for differences. The population of the study comprised all senior secondary school Chemistry students in Niger State in the 2019/2020 academic session which are 20,789 (12,810 males and 7,979 females). The target population was all Senior Secondary School II Chemistry students in Niger state which are 610 (240 males and 370 females) in the 2019/2020 academic session.

### **Sample and Sampling Techniques**

The sample size for this study was drawn from senior secondary school SSII science classes. The intact class of the selected schools was used for the study. A multistage sampling technique was used in this study. Simple random sampling technique was used to select two schools out of 340 senior secondary schools in Niger state. The schools are Government Secondary school, Kontagora, and Ahmadu Bahago Secondary School, Minna. This is because they satisfied the following conditions: co-educational senior secondary schools that is well-equipped with computer facilities and the schools allowed their students and teachers to take part in the study. Simple random sampling technique was used to randomly assign subjects into two groups. Two intact classes were randomly assigned into Vee-Mapping Instructional Strategy and Conventional Teaching Method using simple random sampling techniques.

### **Method of Data Collection**

The researcher visited the selected schools with letter of introduction from the head of department to the various school principals on notification of the intention of the researcher before carrying out the study. There were two days training for the research assistants where they were coordinated on how to handle the two groups. They were exposed to the: purpose of the study, concepts taught; procedure for administering the instrument so as to ensure homogeneity of instructional situation across the groups and teacher for experimental group was trained to use Computer Aided Vee-Mapping Instructional Strategy while the control group was taught with conventional method.



### Method of Data Analysis

Research questions were answered using descriptive and inferential statistics. The descriptive statistics include means and standard deviation and Inferential statistics was used to test the research hypotheses using t-test.

### Result

#### Answering Research Questions

1. Is there any difference in the mean score of students' interest in Organic Chemistry when taught using Computer Aided Vee-Mapping strategy as against conventional teaching method in Senior Secondary School in Niger State, Nigeria?

**Table 1:** Mean and Standard Deviation Interest Score of Computer Aided Vee-Mapping Strategy and Lecture Method in Senior Secondary School Organic Chemistry

Group	N	Posttest		Mean Difference
		X	SD	
Vee-Mapping Strategy	53	77.77	8.11	18.23
Lecture Method	50	59.54	5.76	

Table 1 reveals the Mean interest score and Standard Deviation of students who were taught using Computer Aided Vee-Mapping Strategy and lecture method. The table showed that the Mean interest score of the two groups at posttest differ statistically. Computer Aided Vee-Mapping Strategy had the higher Mean achievement score of 77.77 with Standard Deviation of 8.11, followed by lecture method which had Mean achievement score of 59.54 with Standard Deviation of 5.76. This shows that Computer Aided Vee-Mapping Strategy enhanced better interest of students more than lecture method.

1. What is the difference in the mean score of male and female students' interest when exposed to Computer Aided Vee-Mapping strategy in Senior Secondary School Organic Chemistry?

**Table 2:** Mean interest score and Standard Deviation of male and female students taught using Computer Aided Vee-Mapping Strategy

Group	N	Posttest		Mean Difference
		X	SD	
Male	26	78.19	7.87	0.82
Female	27	77.37	8.46	

Table 2 reveals the Mean interest score and Standard Deviation of male and female students who were taught using Computer Aided Vee-Mapping Strategy. The table showed that the Mean interest score of the two groups at posttest differs a little. Males had the highest Mean interest score of 78.19 with Standard Deviation of 7.87, followed by female students which had Mean interest score of 77.37 with Standard Deviation of 8.46. This shows that male students had higher interest level than female students.



### Research Hypotheses

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

HO<sub>1</sub>: There is no significant difference in the mean score of students' academic achievement taught Organic Chemistry using Computer-Aided Vee-Mapping strategy in senior secondary schools.

**Table 3:** Summary of t-test Analysis of Mean Interest Scores of Students Taught with Computer Aided Vee-Mapping strategy and those Taught with Lecture Method

Group	Variable	N	df	X	SD	t-value	P-value
	Experimental	53		77.77	5.76		
			101			-13.08	.000*1
	Control	50		59.54	8.11		

### \* - Significant at 0.05

Table 3 shows that t-test analysis of the experimental group for posttest was 77.77 and standard deviation was 8.11 while the mean score of control for posttest was 59.54 and the standard deviation was 5.76. The table shows a significant difference in the mean interest score of Computer Aided Vee-Mapping and conventional teaching method [ $t = -13.08$  at  $df = 101$  with  $p = .000$ ]. On this basis Hypothesis one was rejected. This shows that Computer Aided Vee-Mapping Strategy enhanced better interest of students more than lecture method.

HO<sub>2</sub>: There is no significant difference in the mean score of male and female students' interest taught Organic Chemistry using Computer Aided Vee-Mapping strategy in senior secondary schools.

**Table 4:** Summary of t-test Analysis of Mean Interest Scores of Male and Female Students Taught with Computer Aided Vee-Mapping strategy

Group	Variable	N	df	X	SD	t-value	P-value
	Male	26		78.19	7.87		
			51			0.366	0.647
	Female	27		77.37	8.46		

### NS - Not Significant at 0.05

Table 4 shows that the mean score of the male in the experimental group for posttest was 78.87 and standard deviation was 7.87 while the mean score of female posttests was 77.37 and the standard deviation was 8.46. The table shows a no significant difference in the mean interest score for male and female students taught Computer Aided Vee-Mapping [ $t = 0.366$  at  $df = 51$  with  $p = .647$ ]. On this basis Hypothesis two was accepted. This shows that both male and female students had interest in Organic Chemistry when taught using Computer Aided Vee-Mapping Strategy.



### **Summary of Findings**

The findings of the study were that:

1. Students taught Organic Chemistry using Computer Aided Vee-Mapping Strategy performed better than those taught using Conventional Teaching Method.
2. Male and female student's performance were enhanced in the same group of Computer Aided Vee-Mapping Strategy when taught Organic Chemistry.

### **Discussion of Findings**

Computer Aided Vee-Mapping Strategy had a positive impact on the mean interest scores than Conventional lecture method. This finding was supported by Nasrand Asgbar (2011) who used a total of 185 grade 12 students in Isfahan. A 30-item questionnaire provided by authors based on interest towards Biology and found out that students had interest towards science dimensions only Biology is fun for me, had meaningful and positive relation with students' achievement in Biology.

In the same vein, it was also supported by Polacos (2012) who compared the effectiveness of the use of vee-diagrams against that of concept maps in interest in Chemistry concepts. The researcher followed a quasi-experimental and non-equivalent comparison group approach. The experiment involved two classes of third-year students of Licio de Cagayan University High School in Cagayan de Oro City during the school year 2009-2010. Before the intervention, two similar tests were prepared, the pretest (PRT) and the posttest (POT) and interest inventory were carried out. The t-test and Analysis of Covariance (ANCOVA) were used to analyse the data between the PRT and POT. ANCOVA was also used to determine the level of interest. Evidently from the result obtained, students developed a rich system of the concepts and their learning interest of Chemistry was improved. It also agrees with the finding of Safdar, Hussaini, Shah and Tesnin (2013), who depicted how idea and v-graph help in enhancing the standard of learning in the science research facility.

Male students performed better than the female students in the same group of Computer Aided Vee-Mapping Strategy when taught Organic Chemistry though insignificantly. This finding agrees with the finding of Polacos (2012) who compared the effectiveness of the use of vee-diagrams against that of concept maps in interest in Chemistry concepts.

### **Conclusion**

Based on the findings in this study, Computer Aided Vee-Mapping Strategy had a positive impact on the mean interest scores than conventional teaching method. It can be concluded that Computer Aided Vee-Mapping Strategy is user-friendly and easy to use. This is because Computer Aided Vee-maps foster interplay between conceptual and methodological elements and the resultant knowledge or value claims. The knowledge claims are integrated into an individual's cognitive meaning frameworks. Therefore, Computer Aided vee-diagrams are tools that would aid pedagogy that are derived from recent advances in educational theory. The strategies are also gender friendly.



## Recommendations

Based on the findings, the following recommendations are made.

1. Computer Aided Vee-Mapping strategy should be used for teaching and learning processes at all levels of education in Nigerian schools. There is need to integrate learning concepts in the delivery of educational programmes. This will enable the students to learn collaboratively and individually. This could eliminate the problem of poor performance that is due to attention deficit, poor teaching strategies and over-populated classes. Teachers should be ready to adopt the use of ICT in their teaching to enhance better learning.
2. The use of Computer Aided Vee-Mapping Strategy is gender friendly, therefore, it should be encouraged in the classroom to enhance male and female performance in Organic Chemistry at secondary Education level. This will make learning interesting and also improve the male and female students' participation in the classroom.
3. Inclusion and use of Computer Aided Vee-Mapping Strategy in teacher education should be urgently encouraged. This will help in producing teachers who will help the shift from teacher-centered to student-centered approach of learning to enable students take charge of their learning and gather experiences that can help them retain what have been learnt.
4. Workshops and training programmes on the benefits and procedures of using Computer Aided Vee-Mapping Strategy should be frequently carried out by policy makers.

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