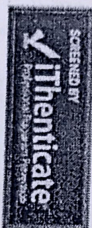
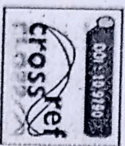


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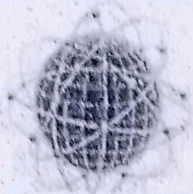
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## **Effects of Computer-Aided Concept-Diagram and VEE-Mapping Strategies on Organic Chemistry Learning Outcome among Senior Secondary School Students in Niger State, Nigeria**

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### **Abstract**

*The study investigated the effects of Computer-Aided Concept and Vee-Mapping Strategies on Senior Secondary School Students' Learning Outcomes in Organic Chemistry In Niger State, Nigeria. The study has two objectives, answered two research questions and tested two null hypotheses. The study adopted quasi-experimental research design where an experimental and a control group were used. Two secondary schools were selected and designated as Experimental Group I and Experimental II with a sample size of 57 (26 Males and 27 Female). Reliability coefficient of 0.86 was obtained when Organic Chemistry Achievement Test was administered on the students. The research questions were answered using mean and standard deviation while Analysis of Variance (ANOVA) was used to test the hypotheses using Statistical Package for Social Sciences (SPSS) Version 20 to conduct the statistical analysis. The study revealed that students taught Organic Chemistry using Vee-Mapping Strategy performed better than those taught using Computer-Aided Concept-Diagram. Also, female students performed better than the male students in the same group of Vee-Mapping Strategy when taught Organic Chemistry. Based on the findings, it was recommended that Vee-Mapping Strategy should be used for teaching and learning processes at all levels of education in Nigerian schools.*

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### **I. Introduction**

Education generally is a vital instrument to technological and socio-economy development of every nation. Similarly, Chemistry is a discipline that contributes to the upliftment of human kind's living standards through the provision of health and other social amenities. It is one discipline upon which technological advancement is hinged (Broman & Parchmann, 2014). 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 has being 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.

Chemistry education contributes to society's 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) 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 industry sector especially in water purification, 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 these indispensable knowledge richly acquired from chemistry education, 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. It is the vehicle through which chemical knowledge and skill reach the people who are in need of capacities and potentials for development. However, adequate teaching method could be a panacea for effective way of helping student to understand organic chemistry. Hence, concept-diagram and vee-mapping strategies aided with computer is worthy of investigation. In view of the importance of chemistry and organic chemistry, literature has highlighted underachievement in chemistry education due to the use of teacher-centered

instructional strategies. Hence the need for student centered strategies like Concept Diagram and Vee-Mapping that could enhance students' performance.

Concept diagram have their origin in the learning movement called constructivism. In particularly constructivists hold that learners should actively construct knowledge. Novak and Canas (2004) asserted that one of the reasons concept diagram is so powerful for the facilitation of meaningful learning is that it serves as a kind of template or scaffold to help to organise knowledge and to structure it, even though the structure must be built up piece by piece with limits of interacting concept and propositional framework.

Vee-mapping is another 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 observes (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. The right hand side represents the methodology, often referred to as the methodological side. The right hand side highlights the knowledge and value claims as well as data recording and transforming procedures. Placed in the middle of the vee-map is the focus question and events or objects to be observed in the learning process.

The central idea in using a vee-map is that every element shown is interdependent with every other element on the vee. The fundamental assumption is that knowledge is not absolute, but rather it is dependent upon the concepts, theories and methodologies by which we view the world. 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, concept diagram and vee-diagrams are tools that would aid pedagogy that are derived from recent advances in educational theory (Novak & Godwin, 1983). These 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.

Computer-aided concept diagram refers to the use of computers in instruction of science concepts. These modes of instructions are interactive and can illustrate a concept through attractive animation, sound and demonstration. It allows students to progress at their own pace and work individually. 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 concept-diagram and vee-diagram instructional strategies will incorporate the use of computer instruction and other ICT tools with concept-diagram and vee-mapping. Computer-aided concept-diagram and vee-map tools will allow the user to point and drag a concept or group of concept to another place on the diagram and map and automatically update all the appropriate links (Anderson-Inma & Zeitz, 2013). Zubairu, Gambari and Agbor (2017) asserted that the use of computer-based concept-diagram instructional strategy has no significant effects on students' performance in Physics while Yusuf and Afolabi (2013) reported from their studies that computer assisted instruction has significant effect on students' performance in science.

Learning outcomes in this study describe measurable skills, abilities, knowledge or values that students should be able to demonstrate as a result of completing a programme of study which includes academic achievement, interest and retention. Achievement is the result of secondary school students in Chemistry over a given time especially at the end of academic session (Ganai & 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 the academic achievement is the extent of which a person has achieved 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. Most of the methods used in teaching have been described as inappropriate and uninspiring. Avaa (2012) alluded that learners are faced with different needs and take different actions to achieve those goals. It is therefore wrong to assume that one approach to enhancing achievement is suitable for all learners. Shehu (2013) stated that part of the blame for low achievement in Chemistry was laid on lack of or inadequate teaching method.

Namasaka and Keraro (2013) investigated the effects of using concept and vee-mapping strategy teaching approach on secondary school students achievement in Biology. A non-equivalent control group design under the quasi-experimental research was used in which a random sample of 4 co-educational secondary schools was obtained in Nasia-Gisha District of Kenya. These 4 schools were randomly assigned to four groups. Each schools provided one form two class for the study, hence a total of 144 students were involved. Students in all the groups were taught the same Biology content but in two groups they were taught through concept and vee-mapping approach while the rest were taught using regular teaching methods. Two groups were pre-tested

prior to the implementation of CVMS treatment. At the end of teaching, all groups were therefore post-tested using student motivation questionnaire (SMQ1 and SMQ 2). The data was analysed using on-way ANOVA and t-test. The results show that students exposed to CVMS approach have significantly higher achievement than those taught through regular methods. The researchers concluded that CVMS is an effective teaching approach which all science teachers should be encouraged to use.

Thoron and Meyers (2013) researched the impact of two developmental appraisal systems on understudy content learning accomplishment. The impacts of conventional composed lap reports was contrasted with the utilization of the vee-map in 18 agric science training classes found inside nine diverse optioned schools. Using understudy pretest scores as a covariate, there was a factually noteworthy distinction between gatherings on the posttest. Despite replication in the study, understudy mean posttest scores more constantly higher in classes using the vee-map. 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 at material science particularly the adequacy and effectiveness of these apparatus were 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.

Akeju, Rotimi and Kenni (2012) investigated the effects of teaching with concept mapping strategy on learning achievement in Nigeria secondary schools. The research study adopted the quasi-experimental research design. The population comprised of a sample of 168 senior secondary school class two (SSII) across Ekiti State. There were two activity groups, the experimental and control groups. The research study were two types, namely uncompleted MCM (Motion Concept Map) which the experimental group were required to complete, and used as pre-test and post-test respectively and printed materials which comprised of two parts. 20 simple structured sampled questions relating to the knowledge of the presented concept was used to measure level of cognition and part B of 10 structured questions administered as post-test to the experimental group only. The post-test to the experimental group only. The post-test for both groups was administered two weeks after the treatment, mean, standard deviation and t-test were used to analysed students deviation and t-test were used to analyse students' achievement. The major findings of the study was that there was a significant effect of the instructional strategy on students' learning achievement and experimental group were able to recall a higher percentage of learned material.

In a study carried out by Olalere (2016) on the effects of vee-mapping on achievement and retention in chemistry quantitative analysis among secondary school students in Kontagora, Niger State. The sample size for the study was 88 students (46 for experimental and 42 for control). Qualitative Analysis Achievement Test (QAAT) and Qualitative Analysis Retention Test (QART) were the instrument used for the study. Data collected from scores obtained from QAAT and QART instruments were analysed using SPSS version 20. The results showed that there is significant difference in the pretest means score of experimental and control using vee-mapping strategy. The result also revealed that male students performed well and higher in vee-mapping qualitative analysis retention test than female counterparts.

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 therefore becomes crucial in this study. Also, the interactive evidence in academic achievement due to gender has necessitated the need to verify how computer-aided concept-diagram and vee-mapping instructional strategies can influence students' achievement, interest and retention in organic chemistry. Therefore, there is need to examine the effects of computer-aided concept diagram and vee-mapping strategies on senior secondary students learning outcomes in Organic Chemistry in Niger State, Nigeria.

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

Chemistry is a popular science subject among senior secondary school students in Nigeria due to its nature. It addresses the needs of majority through its relevance and functionality in content, practice and application. What many nations like Nigeria need now is a functional chemistry education that will assist in national development and society integration. One area of chemistry where students demonstrate a lot of challenges with respect to building authentic mental models is organic chemistry. Adequate understanding of organic chemistry is a pre-requisite for many graduates 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 product of food flavour, plastics, clothing, car tyre, fuels, cement, pharmaceuticals and house cleaning agents.

Despite the relevance of chemistry to national development, the performance of students in chemistry has been quite unsatisfactory over the years (Olorunkoba, 2016). Factors adduced to this poor performances are poor understanding of general principle and concepts of organic chemistry and teaching approaches that is employed by most teachers among others. These methods has been summarised to be expository that is, concentrate on presentation of concepts, facts and principles by the teachers while students are merely asked to

listen and notes. The traditional methods being used does not improve the achievement, retention and the interest of the students in their academic pursuit. This was evidenced in West African Examination (2017) examiner's report that revealed the mean score of 36.05 and standard deviation of 15.62 of 167,492 candidates that sat for WAEC May/June 2017 chemistry paper. This score 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. This scenario signal a bad omen to the nation education standard if proper action is not taken. Science educator however, come to a conclusive agreement as many researches has been ongoing on how to involve students in learning process and science educator have come up with concept-diagram and vee-mapping instructional strategies as one of such teaching-learning strategies. This study therefore, seeks to examine the effects of computer-aided concept-diagram and vee-mapping strategies on learning outcomes of students in senior secondary school year II (SSII) organic chemistry in Niger State, Nigeria.

## **II. Aim and Objectives of the Study**

The aim of this study is to determine the effects of computer-aided concept-diagram and vee-mapping strategy on senior secondary school students' learning outcomes in Organic Chemistry in Niger State, Nigeria.

The study sought to achieve the following objectives by determining;

1. the effect of Computer-Aided Concept-Diagram and Vee-Mapping strategy on academic achievement of Senior Secondary School students in Organic Chemistry.
2. the effect of Computer Aided Concept-Diagram and V-Mapping Strategies on the academic achievement of Senior Secondary School male and female students in Organic Chemistry.

### **Research Questions**

The study was guided by the following questions.

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

## **III. 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 Concept-Diagram and Vee-Mapping strategy in senior secondary schools.
- HO<sub>2</sub>: There is no significant difference in the mean score of male and female students' achievement taught Organic Chemistry using Vee-Mapping strategy in senior secondary schools.

## **IV. Methodology**

A quasi-experimental research design was adopted in this study. It is a pretest, posttest, non-randomized and non-equivalent experimental and control group design. Three groups were used for the study, it included computer-aided concept-diagram and vee-mapping instructional strategies for experimental groups I and II while conventional teaching method was used for control group. A total of fifty-three (53) secondary school students consisting of fourteen (14) males and twelve (12) females for experimental group I and fifteen (15) males and twelve (12) females for experimental group II were selected using simple random techniques.

The instruments which are concept-diagram, vee-mapping instructional strategies and organic chemistry Achievement Test developed were validated by experts by looking at clarity and sustainability of the treatment instruments and face and content validity for organic chemistry Achievement Test.

Kuder-Richardson (RR21) was used to find the reliability of the study and reliability coefficient of 0.86 was obtained for organic chemistry Achievement Test (OCAT). Research questions were answered using descriptive statistic of mean and standard deviation and inferential statistics was used to test the hypotheses which were Analysis of covariance (ANCOVA) to test if the result of protest is significant at  $P < 0.5$  and Analysis of Variance (ANOVA) as control for initial difference across groups.

## **V. Results**

### **Answering Result Questions**

What is the difference in the mean score of students' academic achievement when exposed to Computer-Aided Concept-Diagram and Vee-Mapping strategy in Senior Secondary School Organic Chemistry?

**Table 1: Mean and Standard Deviation Achievement Score of Computer-Aided Concept-Diagram and Vee-Mapping Strategy in Senior Secondary school Organic Chemistry**

Group	N	Posttest		Mean Difference
		$\bar{X}$	SD	
Computer-Aided Concept-Diagram	26	71.13	8.10	6.31
Vee-Mapping Strategy	27	77.44	5.38	

Table 1 reveals the Mean achievement score and Standard Deviation of students who were taught using Computer-Aided Concept-Diagram and VeeMapping Strategy. The table showed that the Mean achievement score of the two groups at posttest differ statistically. Vee-Mapping Strategy had the highest Mean achievement score of 77.44 with Standard Deviation of 5.38, followed by Computer-Aided Concept-Diagram which had Mean achievement score of 71.13 with Standard Deviation of 8.10. This shows that Vee-Mapping Strategy enhanced better achievement of students more than Computer-Aided Concept-Diagram.

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

Group	N	Posttest		Mean Difference
		$\bar{X}$	SD	
Male	14	75.10	4.84	4.85
Female	13	79.96	5.62	

Table 2 reveals the Mean achievement score and Standard Deviation of male and female students who were taught using VeeMapping Strategy. The table showed that the Mean achievement score of the two groups at posttest differs. Females had the highest Mean achievement score of 75.10 with Standard Deviation of 4.84, followed by male students which had Mean achievement score of 79.96 with Standard Deviation of 5.62. This shows that female students achieved better than male 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 Concept-Diagram and Vee-Mapping strategy in senior secondary schools.

Source of Variation	Sum of Squares	df	Mean Squared	F-Value	P-Value
Between Groups	234.376	1	234.376	4.992	0.030
Within Groups	2394.642	51	46.954		
Total	2629.019	52			

Table 3 showed the ANOVA result of the comparison of posttest scores of Computer-Aided Concept-Diagram and Vee-Mapping Strategy. An examination of the Table shows significant difference in the achievement score of the two groups  $F(1, 52) = 4.99$ ,  $P\text{-Value} = 0.030$ ,  $p < 0.05$ . Therefore, there was significant difference in the mean achievement scores of students using Computer-Aided Concept-Diagram and Vee-Mapping Strategy. On the basis of this, Hypothesis One was rejected.

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

Source of Variation	Sum of Squares	df	Mean Squared	F-Value	P-Value
Between Groups	70.598	1	70.598	2.581	.121
Within Groups	683.698	25	27.348		
Total	754.296	26			

Table 4 showed the ANOVA result of the comparison of posttest scores of male and female students using Vee-Mapping Strategy. An examination of the Table shows no significant difference in the achievement score of the two groups  $F(1, 26) = 2.58$ ,  $P\text{-Value} = 0.121$ ,  $p > 0.05$ . Therefore, there was no significant difference in the mean achievement scores of male and female students using Vee-Mapping Strategy. On the basis of this, Hypothesis Two was accepted.

## VI. Discussion of Findings

Vee-Mapping Strategy had a positive impact on the mean achievement scores than Computer-Aided Concept-Diagram. This finding was supported by Namasaka and Keraro (2013) who investigated the effects of using concept and vee-mapping strategy teaching approach on secondary school students motivation in Biology and discovered that students exposed to CVMS approach have significantly higher motivation than those taught through regular methods. The researchers concluded that CVMS is an effective teaching approach which all science teachers should be encouraged to use. In the same vein, it was also supported by Thoron and Meyers (2013) who researched the impact of two developmental appraisal systems on understudy content learning accomplishment. The impacts of conventional composed lap reports was contrasted with the utilization of the vee-map in 18 agric science training classes found inside nine diverse optioned schools. Using understudy pretest scores as a covariate, there was a factually noteworthy distinction between achievement on the posttest. Despite replication in the study, understudy mean posttest scores more constantly higher in classes using the vee-map. 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.

Female students performed better than the male students in the same group of Vee-Mapping Strategy when taught Organic Chemistry. This finding does not agree with the finding of Olalere (2016) on the effects of vee-mapping on achievement and retention in chemistry quantitative analysis among secondary school students in Kontagora, Niger State. It was revealed that male students performed well and higher in vee-mapping qualitative analysis in achievement test than female counterparts.

## VII. Conclusion

Based on the findings in this study, Vee-Mapping Strategy had a positive impact on the mean achievement scores than Computer-Aided Concept-Diagram. It can be concluded that Vee-Mapping Strategy is user-friendly and easy to use. This is because 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, concept diagram and vee-diagrams are tools that would aid pedagogy that are derived from recent advances in educational theory. The strategies are also gender friendly.

## VIII. Recommendations

Based on the findings, the following recommendations are made.

1. 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 use of ICT in their teaching to enhance better learning.
2. The use of 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 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 Vee-Mapping Strategy should be frequently carried out by policy makers.

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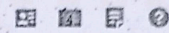
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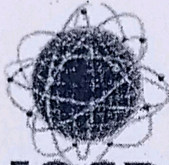
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