



# Concept Mapping Strategy and its Effects on Students' Performance in Senior Secondary School Organic Chemistry in Imo State of Nigeria

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## Abstract

The research study investigated concept mapping strategy and its effects on students' performance in senior secondary school Organic Chemistry in Imo State, Nigeria. The design adopted for the study was quasi-experimental, non-equivalent research design. The population was made up of a sample size of 141 year three senior secondary Chemistry students drawn from four schools in Owerri municipal local government area of Imo State, Nigeria. An instrument titled Performance Test in Organic Chemistry (PTOC) was used for data collection. Mean, standard deviation, t-test and analysis of covariance (ANCOVA) were used to test the research questions and hypotheses using the SPSS package. The findings showed among others that using concept mapping strategy has a significant effect on performance.

**Keywords:** Concept mapping, Performance, Organic Chemistry.

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## INTRODUCTION

Science Education plays a key role for the future of societies. Globally, countries have continually sought to improve the quality of science education particularly developing countries, Nigeria is not left out; there has been a radical shift in views of primary and secondary school teaching and learning. Science can be seen as a gateway to solving societal problems. Effective science learning depends on the method and techniques employed by the teachers during the instructional process. As observed by Olarenwaju (2006), the teaching of science is mainly by lecture method and copying of lecture notes. Due to the role played by the teacher in the conventional teaching method, students do not engage in critical thinking.

Several issues affect the Nigerian educational system, according to one of the most identified one is the level of performance in the sciences by students in both the external and internal examinations. Bojuwoye (2006) asserted that poor performance in science and its effects on the economy of the country has been the major concern of various science educators, and other meaning Nigerians in the education Industry. Education bodies like West African Examinations Council (WAEC), Science Teachers Association of Nigeria (STAN) the federal and state ministries of education set up committees from time to time to look into the reasons for poor performance of students in science. Performance is a task or action carried out in doing of things; how well we do things. Innovative teaching strategies are generally significant in fostering positive performance. In view of the relevance of Chemistry in nearly all aspects of our economy, the poor performance of students in Chemistry at secondary level has partly been blamed on the poor teaching methods used by teachers. Some research findings have revealed that Chemistry students find organic Chemistry difficult (Okonkwo, 2012; Ogbonna, 2014). Ogbonna (2014) also reported the low performance of Nigerian students in Chemistry. Many research reports (Okonkwo 2012; Arokoyu & Obunwo 2014; Ogbonna,2014) have evaluated what goes on in most Chemistry classrooms (where Chemistry is taught and learned) and overwhelmingly concluded that most of the teachers employ the traditional lecture method to teach Chemistry.

Chemistry education is the study of the teaching and learning of chemistry in all schools, colleges and Universities. Chemistry can be defined as a branch of science that deals with changes in matter. The development and sustenance of any form of technology will be a wild goose chase unless a solid foundation is laid for effective and efficient Chemistry education (Okonkwo, 2012). Organic Chemistry, which is the focal point of this study can be defined as the Chemistry of carbon compounds. Organic compounds form the basis of all earthly life and constitute a significant part of human endeavors in Chemistry. Organic Chemistry finds its applications in enormous phases of life, such as: food, medicine, cleansing agents, analytical purposes, explosives, cosmetics, valuables, etc. Organic Chemistry is central to a nation's growth. To get admitted into a tertiary institution in Nigeria to study science related courses a student needs a credit pass in Chemistry. Educators are perturbed to look into and give careful considerations on changes in pedagogy and accept new methods and techniques under prevailing conditions. Therefore to improve on the image of Chemistry (in terms of performance) entails a departure from the old fashioned traditional lecture approach where the teacher benefits the advantages while the disadvantages of the method penalizes students. Instead, problem-based and activity oriented teaching strategies should be identified and adopted (Okonkwo, 2012).

Concept mapping is a strategy that has brought new ways of learning science, other subjects and also representing expert knowledge of individuals, educationists, government, etc.

Concept maps are rooted in constructivism. According to Rao (2015), concept maps are diagrammatic representations which show meaningful relationships between concepts in the form of propositions which are linked together by words, circles, and cross links. The teaching strategy presents a concept in a hierarchical organized manner. Some studies (Arokoyu & Obunwo, 2014; Ogbonna, 2014; Okafor, Abonyi & Ugama, 2016), have opined that concept mapping strategy is a viable educational tool which can help teachers become more effective, fosters curriculum development and promotes students' hands-on activity. Although research support concept mapping as an effective method of acquiring meaningful learning, not enough steps have been taken to apply it to teaching/learning methods in classrooms.

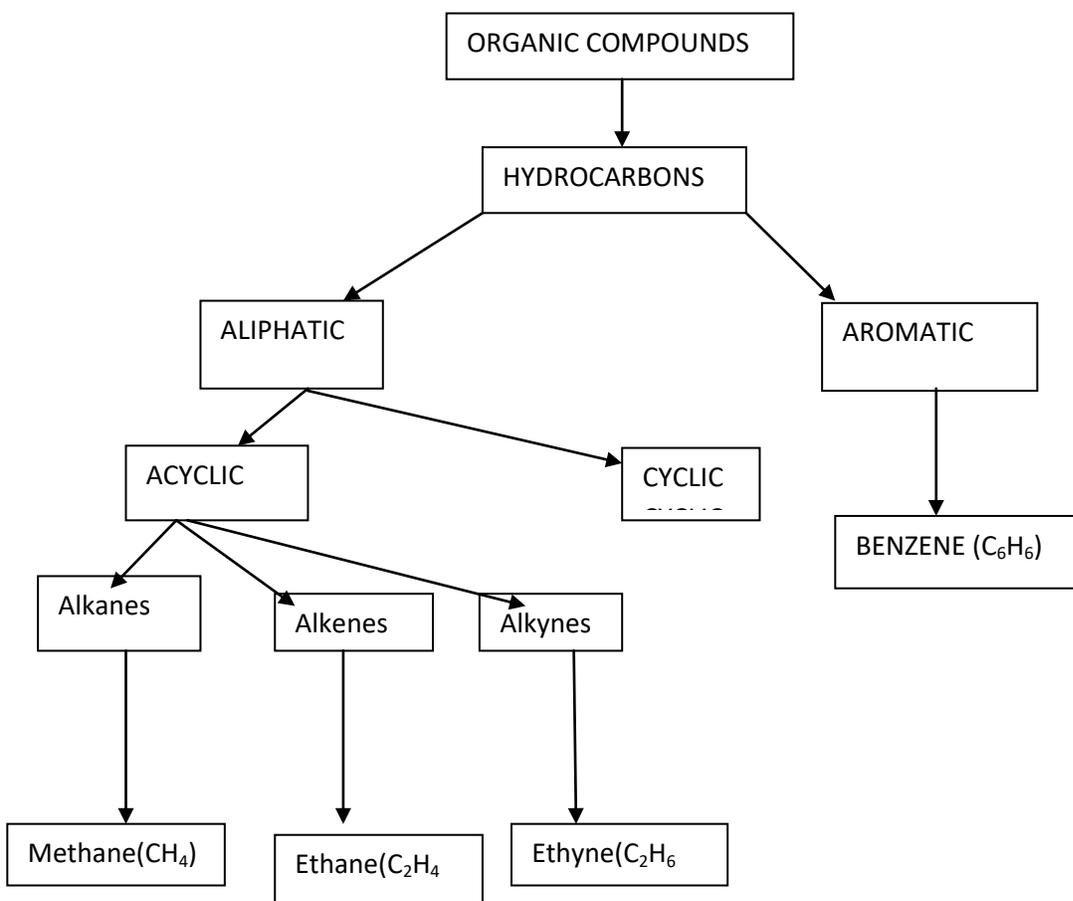


Figure 1: Example of a Hierarchical concept map on organic compounds

Gender can be defined as a socially structured characteristic of females and males in a given society as distinct from sex. Gender stereotyping permeates the school system from the basic education level through the basic level to the tertiary level and manifest in diverse ways. Some researchers have reported the prevalence of significant gender differences in performance of students in Chemistry, some in favour of males, some in favour of females while some found no difference (Okonkwo, 2012; Ahmed & Munawa, 2013; Ogonnaya, Okafor, & Abonyi, Ugama, 2016). Some of these were attributed to factors which include the teaching strategies adopted, religious beliefs, economic, cultural and social belief, etc.

A research was carried out by Egbo (2014) on the effect of concept mapping method of instruction and expository method on students' academic achievement in Chemistry. The

findings show that students taught using concept mapping method achieved higher than those taught using expository method.

Awofala (2011), investigated the effect of concept mapping strategy on performance in mathematics of 88 junior secondary year three Nigerian students. Results showed that concept mapping strategy is capable of improving students' mastery of content at the higher-order levels of cognition.

This study is an attempt to investigate the effect of concept mapping on Chemistry students' performance in organic Chemistry. The study was carried out with SS3 Chemistry students of Owerri municipal local government area in Imo state of Nigeria. This study investigated concept mapping teaching strategy on students' performance level in organic Chemistry. The contents covered are alkanolic acids and alkanooates (esters) in organic Chemistry. The control group was taught using the conventional teaching method (lecture method).

### **Statement of Problem**

The inability of Chemistry students to see the real world application of concepts and principles coupled with the traditional method of teaching have been attributed as the major cause of poor performance in the senior secondary school examination (WAEC) and internal examinations. (WAEC, Annual Reports from 2008-2012). Among the several factors enumerated to account for this poor performance, poor teaching methods seems to be a major contributory factor.

### **Aim and Objectives of the study**

The aim of this study is to investigate concept mapping teaching strategy on students' performance in Organic Chemistry. Specifically the objectives of the study are to:

- Investigate the effect of concept mapping teaching strategy on the performance of students in Organic Chemistry; and
- Compare the effect of concept mapping teaching strategy on male and female students' performance in Organic Chemistry.

### **Research Questions**

The following research questions guided the study:

- What difference exists in the mean performance score of students when taught organic Chemistry using concept mapping teaching strategy?
- What is the effect of concept mapping teaching strategy on male and female students' mean performance score in organic Chemistry?

### **Hypotheses**

- There is no significant difference in the mean performance score of Chemistry students taught organic Chemistry using concept mapping teaching strategy.
- There is no significant difference in the mean performance score of male and female students taught organic Chemistry using concept mapping teaching strategy.

## **METHODOLOGY**

This study adopted a quasi-experimental non-equivalent pre-test, post-test non-randomized control group design. The population of the study was the present year three senior secondary (SSIII) Chemistry students (2017/2018) in Owerri Municipal LGA of Imo State. The estimated population of 1600 students were selected from schools spread across the LGA. The sample consisted of 141 SSIII Chemistry students drawn from four selected public senior secondary schools in Owerri Municipal LGA of Imo State. Random sampling was used for the selection of these schools. Stratified sampling technique was also used to select two female schools and two male schools from the public schools in the local government area. Intact classes from each of these schools were assigned to experimental and control groups respectively.

### **Research instrument and Procedure**

One instrument developed by the researcher was used for data collection. The Performance Test in Organic Chemistry (PTOC). The (PTOC) was for the collection of pre-test performance score and post-test performance score. It was made up of two sections, section A and section B. Section A contains personal data while section B contained the question items. The PTOC was a 25-item, 4-option multiple choice objective test and two practical tests that involve the construction of concept maps. The items covered all the levels of Bloom's taxonomy of educational objectives.

The instrument was subjected to trial testing. The trial testing enabled the researcher to determine the clarity, reliability and appropriateness of the test items. The data obtained from the response of the students in the testing was used to estimate the reliability of the instrument. Kudar-Richardson 21 formula was adopted in determining the reliability co-efficient of the instrument, PTOC and the co-efficient of reliability was found to be 0.62. The instrument was subjected to face and content validity by the project supervisors, two experts in measurement and evaluation in Department of Educational psychology and Curriculum planning, University of Port Harcourt and a Chemistry teacher from a certified secondary school.

The researcher used the help of Chemistry teachers in each of the four schools that were used for the study as research assistants. The research assistants were given a 2-weeks training before the commencement of the instructional process of the research. The experimental groups were given training on how to make concept maps for one week. However one week was also spent with the control group as familiarization period. Measures were also taken to control the extraneous variables.

Mean statistics and standard deviation were used to test the research questions. The data were computed by using (SPSS) Statistics Package for Social Science. There were two hypotheses which the study analyzed using t-test and Analysis of Covariance (ANCOVA) at 0.05 level of significance.

## **RESULT AND DISCUSSION**

**Research Question 1:** What difference exists in the mean performance score of students when taught organic Chemistry using concept mapping teaching strategy?

Table 1: Mean Performance of Students Taught using Concept Mapping Strategy and Conventional Method in Pre and Post-Test.

	Method	N	Mean difference	SD	Mean
Pair 1	CMTS Pre	78	11.89	2.27	-7.73
	CMTS Post	78	19.63	3.54	
Pair 2	CTM Pre	63	11.55	2.24	- 1.48
	CTM Post	63	13.03	2.07	

The table above shows that the mean performance score of students taught using concept mapping strategy in the pre-test and post-test is 11.89 and 19.63 respectively, while the mean performance score of students taught using conventional method in the pre-test and post-test is 11.55 and 13.03 respectively. Table 1 displays the data, thus the mean performance score of students taught using concept mapping strategy and conventional method in the pre-test and post-test is significantly different. This could also be seen from the graphical representations below (fig 2 and 3). This shows a marginal increase in the mean score of the concept mapping teaching strategy over the conventional teaching method.

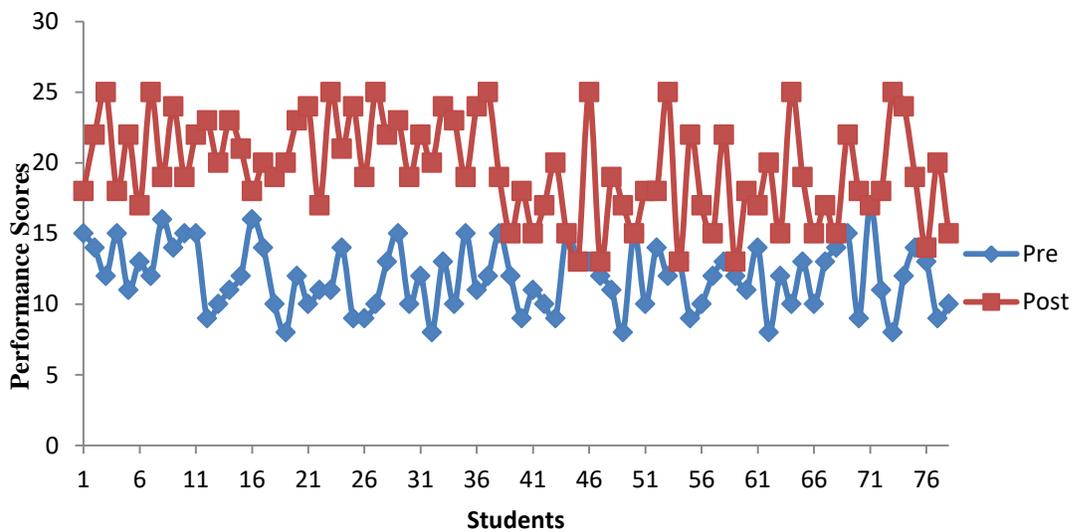


Figure 2: Performance Scores of Students using Concept Mapping Strategy in Pre and Post-Test.

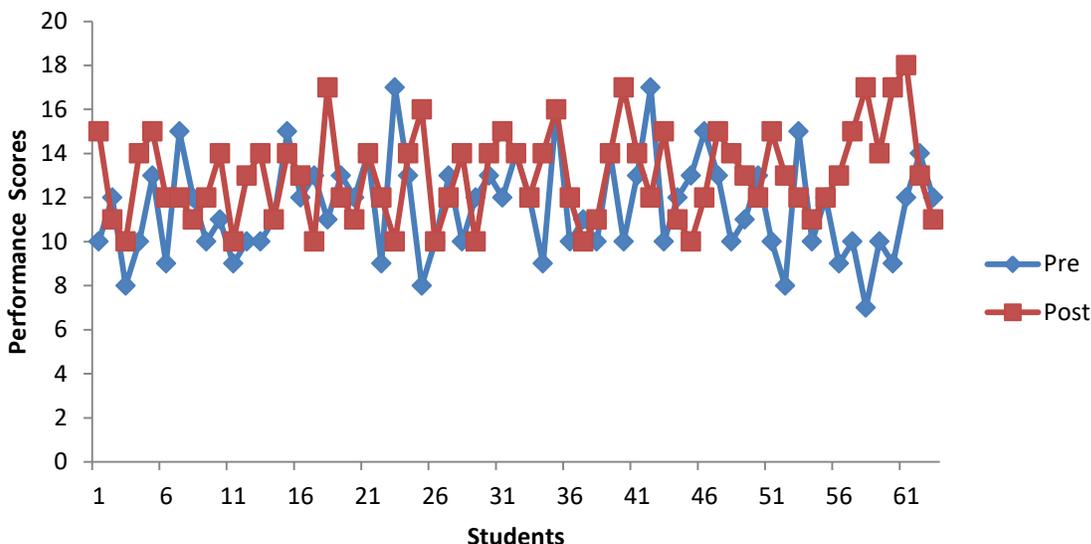


Figure 3: Performance Scores of Students using Conventional Method in Pre and Post-Test

**H<sub>01</sub>:** There is no significant difference in the mean performance score of Chemistry students taught organic Chemistry using concept mapping teaching strategy.

Table 2: t-Test Analysis of the mean performance score of Chemistry students taught organic Chemistry using concept mapping teaching strategy and conventional teaching method

	Method	N	Mean	SD	Mean Difference	Df	T-Cal	P-value	Decision
<b>Pre-Test</b>	Concept Mapping Strategy	78	11.8974	2.271	0.3418	139	0.894	0.373	Not Significant
	Conventional Teaching Method	63	11.5556	2.241					
<b>Post-Test</b>	Concept Mapping Strategy	78	19.6282	3.538	6.5764	139	13.090	0.000	Significant
	Conventional Teaching Method	63	13.0317	2.071					

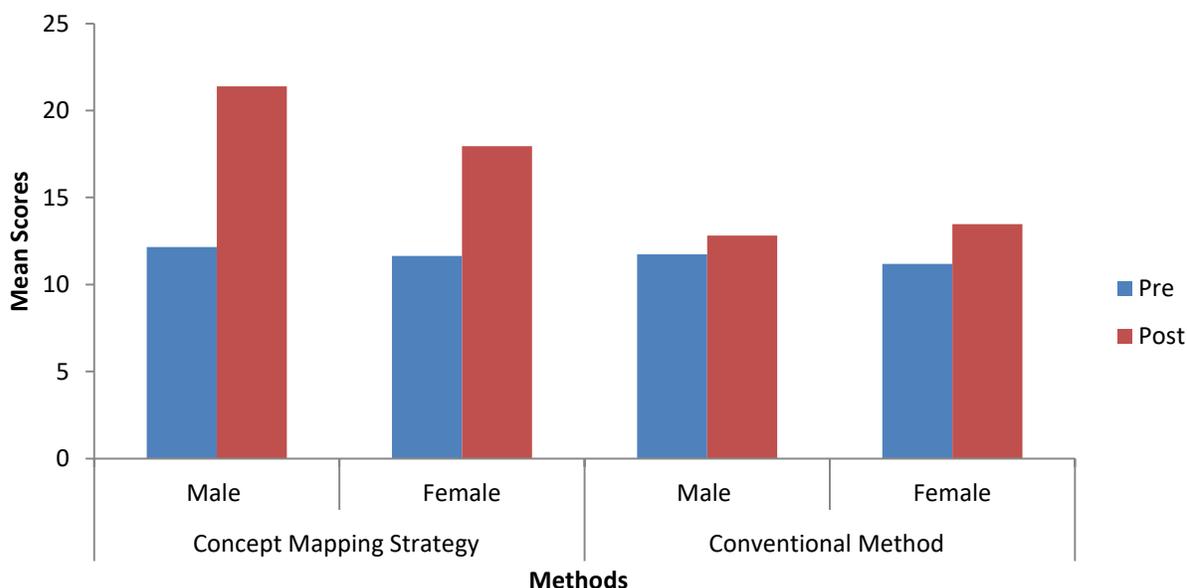
Table 2 shows that the p-value (0.373) is greater than 0.05 significant levels in the pre-test. Thus, significant difference do not exist in the mean performance scores of students taught organic Chemistry with concept mapping strategy and those students taught with conventional method in the pre-test. The table further shows that the null hypothesis is rejected for the post-test because the p-value (0.00) is less than 0.05 significant levels. We therefore conclude that there is significant difference in the mean performance scores of students taught organic Chemistry with concept mapping strategy and the students taught with conventional method in the post-test.

**Research Question 2:** What is the effect of concept mapping teaching strategy on male and female students' mean performance score in organic Chemistry?

Table 3(i): The effect of male and female students' means performance score in organic Chemistry when taught using concept mapping strategy and conventional method

		Concept Mapping Strategy		Conventional Method	
		Mean	SD	Mean	SD
<b>Pre</b>	Male	12.16	2.33	11.74	2.27
	Female	11.65	2.21	11.19	2.18
	<b>Total</b>	<b>11.90</b>	<b>2.27</b>	<b>11.56</b>	<b>2.24</b>
<b>Post</b>	Male	21.39	2.52	12.81	2.00
	Female	17.95	3.57	13.48	2.18
	<b>Total</b>	<b>19.63</b>	<b>3.54</b>	<b>13.03</b>	<b>2.07</b>

Table 3(i) implies that there was an improvement in the mean performance of students, thus concept mapping has significant effect on students. Also, student taught using conventional method had 11.74 and 11.19 for male and female students in the pre-test respectively, while in the post-test male students had mean score of 12.81 and female students had 13.48, showing an insignificant improvement. From the table and fig 4.3, the mean performance scores of students taught using concept mapping strategy is higher than the mean scores of students taught using the conventional method. However, there is effect of gender on students' means performance score in organic Chemistry when taught using concept mapping strategy but there is no effect of gender on students' means performance score in organic Chemistry when taught using



Conventional method.

Figure 4: Mean Performance Scores of Students Taught Concept Mapping Strategy and Conventional Method in Pre and Post-Test.

Table 3(ii): ANCOVA analysis on the effect of male and female students' means performance score in organic Chemistry when taught using concept mapping strategy and conventional method

Method		Independent	Dependent	Df.	F	p-value	Decision
Concept mapping	Pre-test	Gender	Performance scores	1	0.974	0.327	Not Significant
	Post-test	Gender	Performance scores	1	23.976	0.00	Significant
Conventional method	Pre-test	Gender	Performance scores	1	0.833	0.365	Not Significant
	Post-test	Gender	Performance scores	1	1.461	0.231	Not Significant

The ANCOVA result above shows that the effect of gender on students' means performance score in organic Chemistry when taught using concept mapping is not significant. But for post-test, the null hypothesis is rejected. Table 3(ii) indicates that the p-value (0.00) is less than 0.05 significant levels. Therefore, the effect of gender on students' means performance score in organic Chemistry when taught using concept mapping is significant in the post test. However, the effect of gender on students' means performance score in organic Chemistry when taught using conventional method is not significant in the pre and post-test because the p-value (0.365 and 0.231) is greater than 0.05 significant levels respectively.

**H<sub>02</sub>:** There is no significant difference in the mean performance score of male and female students taught organic Chemistry using concept mapping teaching strategy.

Table 4(i): t-Test Analysis of the mean performance score of male and female students taught organic Chemistry using concept mapping method

	Gender	N	Mean	SD	Mean Difference	Df.	T-Cal	P-value	Decision
<b>Concept Mapping Strategy</b>	<b>Pre-Test</b>	<b>Male</b>	38	12.157	2.331	0.5078	76	0.987	Not Significant
		<b>Female</b>	40	11.650	2.213				
	<b>Post-Test</b>	<b>Male</b>	38	21.394	2.520	3.4444	76	4.897	Significant
		<b>Female</b>	40	17.950	3.573				

From Table 4(i), the p-value (0.327) is greater than 0.05 significant levels in the pre-test but the p-value (0.000) is less than 0.05 significant levels in the post-test. We therefore conclude that there is no significant difference in the mean performance score of male and female students taught organic Chemistry using concept mapping in pre-test. But the mean performance score of male and female students taught organic Chemistry using concept mapping strategy is significantly different in the post-test.

Table 4(ii): t-Test Analysis of the mean performance score of male and female students taught organic Chemistry using conventional teaching method

		Gender	N	Mean	SD	Mean Difference	Df	T-Cal	P-value	Decision
<b>Conventional Teaching Method</b>	Pre-Test	Male	42	11.738	2.274	0.5476	61	0.913	0.365	Not Significant
		Female	21	11.190	2.182					
	Post-Test	Male	42	12.809	2.002	0.666	61	1.209	0.231	Not Significant
		Female	21	13.476	2.182					

Table 4(ii) indicates that the p-value (0.365 and 0.231) is greater than 0.05 significant levels respectively. We therefore conclude that there is no significant difference in the mean performance score of male and female students taught organic Chemistry using conventional teaching method in pre and post-test. The t-test result in table 4(ii) shows that the null hypothesis is accepted for pre and post-test.

## DISCUSSION OF FINDINGS

The result presented in table 1 and 2 shows that students in experimental group (concept mapping) had a higher mean performance score than students in the control group (Conventional teaching method). This is an indication that teaching methods, especially the innovative strategy (concept mapping) has significant effect on students' performance in organic Chemistry. The observed probability value of 0.000 which was significant at 0.05 level of confidence gives credence to the result. This implies that the effectiveness of the two teaching methods with regards to performance in organic Chemistry is in disparity. In other words (therefore) students' performance in concept mapping method appears superior to the conventional method. This result gives credence to Okonkwo (2012) and Egbo (2014), who asserted that teaching strategies have significant effect on students' performance in Chemistry.

A significant feature in concept mapping which might have contributed to its mapping offers learners the opportunity to participate and be actively involved in the whole process of teaching and learning. Ahmad and Munawar (2013) and Okonkwo (2012) attested to this, that activity oriented teaching and learning strategies promotes understanding and retention of information. Concept mapping supports learning anchored on prior knowledge hierarchically arranged and well organized which brings about meaningful learning and discourages rote learning. Concept mapping strategy places the responsibility of learning directly on the students, which makes them actively involved in the learning process.

The result presented on Table 4(i) shows the scores of both males and females in the two groups for pre and post test scores. Table 4(ii) further revealed that the mean performance score of students taught using CMTS was significantly influenced by gender. This is an indication that gender inclusive science teaching strategy influenced the mean performance score of the students in their concept mapping Chemistry activities. This result is in agreement with Ifeakor (2005) and Okonkwo (2012) asserted that gender had an effect on performance. But in variance with Ogonnaya, Okafor, Abonyi, and Ugama (2016) who reported that no significant difference exists in the performance mean scores of the male and female respondents. Therefore, a gender

balanced atmosphere accounted for the superiority of concept mapping in enhancing performance over the conventional method.

## **SUMMARY**

The study reveals the following findings:

- The mean performance score of students taught using concept mapping strategy and conventional method in the pre-test and post-test is significantly different.
- There is significant difference in the mean performance scores of students taught organic Chemistry with concept mapping strategy and the students taught with conventional method in the post-test.
- The mean performance scores of students taught using concept mapping strategy is higher than the mean scores of students taught using the conventional method. However, there is effect of gender on students' mean performance score in organic Chemistry when taught using concept mapping strategy but there is no effect of gender on students' mean performance score in organic Chemistry when taught using conventional method.
- There is no significant difference in the mean performance score of male and female students taught organic Chemistry using concept mapping in pre-test. But the mean performance score of male and female students taught organic Chemistry using concept mapping strategy is significantly different in the post-test. Consequently, there is no significant difference in the mean performance score of male and female students taught organic Chemistry using conventional teaching method in pre and post-test.

## **CONCLUSION**

Students taught organic Chemistry using concept mapping strategy outsmarted those taught using the conventional method. Concept mapping teaching/learning strategy is more effective in achieving instructional objectives in organic Chemistry compared with the conventional method. Concept mapping strategy motivates students towards an independent practice of chemistry instead of direct instruction.

When learners are actively involved in the learning, they are bound to achieve more than learners that learn passively. In the research it can also be concluded that the attainment of academic excellence is not a function of the sex one belongs to. Both male and female learners are co-learners and no one is superior to the other.

## **Recommendations**

Based on the foregoing, the following recommendations were made;

- Since concept mapping strategies were found efficacious in engendering students' performance in Chemistry. Chemistry teachers should incorporate this instructional technique in teaching. This could help improve students' performance in Chemistry.
- Workshops serve as avenues for creating awareness of emergent knowledge and innovations in pedagogy and for the reorientation of both in-service and pre-service teachers to new developments in pedagogy or to unfamiliar but useful strategies.

- The Ministry of Education and other relevant bodies should organize workshops from time to time for Chemistry teachers for the purpose of sensitizing, developing and using concept mapping strategies and other innovative learning strategies in suitable areas of Chemistry.

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