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# Influence of Concept Maps on Achievement Retention of Senior Secondary School Students in Organic Chemistry

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**Introduction**

Ausubel's (1960) cognitive theory held the idea that learning takes place by the assimilation of new concept into concepts frameworks already held by the learner. Ausubel stated that for learning to take place teaching must go along with language and examples related to learners prior knowledge. He advocated that rote learning, which is simply memorizing concepts, definition, statements or procedures, does not lead to meaningful learning. For meaningful learning to also take place in the learner there must be motivation, which enables learner to choose to learn by incorporating new learning into the prior knowledge. Concept map according to Novak and Godwin (1994) is one of the tools or methods which provide motivation to the learner for meaningful learning to take place.

Maps are sketch representing an idea or concept. In Geography maps represent on a paper, an area, country etc showing the towns, cities, rivers, mountains etc. It also shows the distances between towns and the connections from town to town on roads, railways etc. In education, concept maps according to Wandersee (1990) are a construct of a bounded graphic representation that corresponds to a perceived reality. Just as geographic maps, concept map shows sketch of concepts and it uses prepositions to show the direction and relationship among the concepts. Hence Novak and Godwin (1984) described concept map as a schematic device for representing set of concept meanings in a frame work of prepositions. They also described it as a hierarchical representation of concepts. This means that concepts are arrange on a paper, from general to specific, relating one concept to another by use of linking prepositions. The major concept is differentiated from the subordinate ones by use of squares to bind it. The supper-ordinate and sub-ordinate concepts are bounded with circles, while the examples are bounded with eclipses. (see the attached examples). Linking prepositions are formulated in a simple way which gives meaning to the map and makes for easy understanding of the map.

The understanding of the learner and the interest which this understanding builds provide a structure into which the new concept to be learnt can be integrated into the learned concepts that the learner already possessed. That was why Novak (1990) stated that "concept mapping has become an important tool to help students learn to learn meaningfully and to help teachers become more effective teachers". Mapping is showing a map, or makes a map. Concept mapping as stated by Novak has various uses. As describe by Novak, it is used as advance organizer and it can be used as a powerful evaluation tool. The students construct maps to show the summary of what they have been taught. The teacher goes through their maps and then determines whether the student has learnt what he /she taught them. The students can also use their maps to evaluate their understanding to what they have been taught. It can be used to show prior knowledge about a given topic. This is its use as entry behaviour. The teacher asks the students to concept map a topic before he/she goes into the teaching. The teacher at the end of the lesson can construct a concept map or display an already constructed map to summarize a lesson. The students at the end of the lesson can also construct a map to show the understanding and retention of what they have learnt. Achievement retention is very necessary in the teaching of chemistry in secondary schools in Nigeria.

According to the National Policy on Education (FME 2004) the broad aim of the senior secondary education is: preparation for useful living in the society and preparation for higher education. Chemistry is very necessary for the realization of these aims. Chemistry prepares professionals such as medical doctors, pharmacist's chemistry teachers, chemical engineers biologists engineering. Chemistry is also very useful for living in the society. One has to choose the texture and colour of cloths to wear, the food to eat, the taste of the food and the make – up, the acidic and basic properties of such food, the water to drink, the fertilizer, herbicides to apply etc. Chemistry therefore equips the individual with necessary knowledge, skills and attitudes to enables, him/her interact meaningfully with the environment, and solve life problems in the society. One is expected after studying chemistry at the senior secondary school level to be self reliant and help to build the Nigerian nation scientifically and technologically. The knowledge of chemistry should help the recipients to go into the manufacturing and processing of industries. The organic chemistry is the aspect of chemistry that deals with manufacturing and processing of many organic materials such as petroleum and many synthetic materials.

Generally, students achieve poorly in chemistry as observed by WAEC (West African Examination Council Chief Examiners Report 2006-2009) Udo and F Shiet 2007 and Okonkwo 2010. Unfortunately the achievement in organic chemistry is not good as reported by Ezeudu (1995). Researchers such as Okonkwo

 

(2010) and Udo and Eshiet 2007, reported that the reason for the failure in chemistry is due to inappropriate teaching methods used by the teachers. Menis & Fraser (1992) reported that student found organic chemistry too difficult. When concepts in organic chemistry appear too difficult and students achieve poorly, one may be forced to conclude that students do not remember the facts or concepts learnt during examinations. Students were taught by the teachers. They read and prepared for the examination but coming to the pubic examination hall, they forget the facts, concepts and principles. This researcher is personally interested on how to improve the achievement retention of the students. Achievement retention has the principles that if the facts, concepts or principles were retained then the students will achieve highly. Chanhan (1981) listed the following as means through which students can retain what they learnt: over – learning, learning meaningfully, use of mnemonics, self recitation and formation of clear concepts.

Roth (1994) in the article titled effects of concept and vee mapping under three learning modes on students' cognitive achievement in ecology and genetics quoted Jonathan in grade 11 saying "concept mapping did help me to understand the most resent chapter because the more you talk about something and the more you apply it to every day uses, the more your understanding of the chapter grows." Jegede, Alaiyemola and Okebukola (1990) sought to find out if the metacognitive strategy of concept mapping reduces anxiety and thereby enhances achievement in Biology. The following findings were obtained. Concept mapping was significantly more effective than tradition/ expository teaching strategy in enhancing learning in biology. It also reduced students' anxiety towards learning of biology. A significant reduction of anxiety was noticed for male students. Roth and Roychoudhury (1993) did some work on the topic the concept mapping as a tool for collaborative construction of knowledge - A microanalysis of high school physics students. The study was designed to investigate the use of concept mapping as a means of assessing the quality of students' understanding from two perspectives which were analysis of process of constructing meaning and analysis of products of cognitive activity. The result showed that concept mapping led to the sustained discourse on the topic and it improved the declarative knowledge of many students.

Nworgu (2006) described conventional lecture method as the verbal presentation of concepts and ideas to the students. This method can be used to teach organic chemistry but it relies more on textbooks. It assumes that the teacher knows it all and she/he pour the knowledge on the students. Ezeudu (2011) commenting on the merits of lecture method said that large course content are covered within a limited time, and distractions on the part of the students are removed as the method keeps them thinking all the time. As the students write faster, their co-ordination, listening and writing abilities improves and these help them when they embark on independent studies and research at higher educational levels. The paper will find out which of the methods will give greater achievement retention to students in organic chemistry and also find out if gender will affects students in the study of organic chemistry.

Gender, according to Okeke (2008), is the social or cultural characteristics, rotes or behaviour which males and females are known for by society. Okeke further stated that sex is universal and biologically determined such as possession of penis by the males and vagina by the females. Onyegegebu (2008) referred to gender as the sum total of cultural values, attitudes, roles practices and characteristics based on sex. Onyegegebu further described sex as the innate biological differences between women and men. So both women and men differ by their physiology. Okeke (2008) described the men as bold, tactful, intelligent, aggressive etc and the women as dull, passive, submissive, talkative etc. Could these attributes affect their achievement in chemistry? The obvious answer is no, because factors such as sex-role stereotyping, female socialization process, masculine images in chemistry textbooks exhaust could contribute to the observed differences in achievement of boys and girls. The difference could also be attributed to what Nnaka (2008) reported that girls do not get encouragement in science classes from the teachers, rather they make negative comments to girls about kind of work/course girls should undertake. Although some researchers, Ugwuanyi (2012) reported that girls did betters than boys in students' conceptual understanding of force and motion. Ndina and Wagbara (2012) showed that girls had greater influence on their attitude towards chemistry than boys. On the other hand, Madu (2004), Iweka (2006), Obiekwe (2008), Agomaoh (2010) and Ukozor (2011) reported that boys achieved better than girls in sciences. Other researchers, Nzewi (2010, 2011), Okeke (2007), Viko (2002), Basel (2006), and Onimis, (2006), showed that gender has insignificant effect on science achievement. Okoro (2011) opined that instructional method used in the classroom may influence gender and students' academic achievement in science. Okoro also further supported the argument that females performed better than males when co-operative learning strategy is used. On the other hand, when competitive or individualized learning strategy is used males did better than females. The inconsistent results on gender generated the need for further study. Also evidence from literature available to the researcher does not show that any conclusion has been reached on the influence of gender on students' achievement and retention when taught with two teaching strategies. Therefore the focus of this study is to find the interactive effect of concept map and lecture teaching methods on gender as a social construct on achievement, retention of students on organic chemistry. Could concept mapping be gender sensitive?

**Purpose of the Study**

The main purpose of this study is to investigate the effect of concept maps on achievement retention in organic chemistry among senior secondary school students. Specifically the study tends to determine:

1 The influence of concept maps and lecture teaching methods on students' achievement mean scores and mean retention scores in organic chemistry.
2 The influence of gender on student's achievement mean scores and retention mean scores in organic chemistry when taught with concept maps and lecture teaching methods.
3 The interaction effect of teaching methods and gender on students' achievement and in organic chemistry.

**Research Questions**

The following research questions guided the study:

1. What is the students' achievement mean scores and retention mean scores in organic chemistry when taught with concept maps and lecture method?
2. What influence has gender on students' achievement mean scores and retention mean scores in organic chemistry when taught with concept maps or with lecture method?
3. How will concept maps and lecture method interact with gender to influence student's achievement and retention in organic chemistry?

**Hypotheses**

The following null hypotheses guided the study and they were tested at 5% probability level.

**$H0_1$:** There is no significant difference between the mean achievement scores and mean retention scores of students taught with concept maps and those taught with lecture method.

**$H0_2$:** Gender will not be significant factor in mean achievement scores and mean retention scores of students taught organic chemistry with concept maps and those taught with lecture method.

**$H0_3$:** There will be no significant interaction between concept maps and lecture method with gender on student's achievement and retention in organic chemistry.

**Research Design**

Design of this study is quasi-experimental study design. It is pretest-posttest non equivalent control group design. This is because the researcher cannot randomly sample and assign the subjects to experimental groups. They are already in intact classes (Ali, 2006). According to Nworgu (2006) it is an experiment where it is not possible to assign the subjects to experimental and control groups. The design is represented below as:

$0_1$ x $0_2$ $0_3$
---
$0_1$ -x $0_2$ $0_3$

Where:

$0_1$ = Pre-tests Scores
$0_2$ = Posttest Scores
$0_3$ = Retention Scores
x = Experimental treatment using concept maps
-x = Control treatment using lecture method
----- = It shows that both experimental group and control group are not randomly composed.

**Area of the Study**

The area of the study is Nsukka Education Zone of Enugu State, Nigeria. The zone is made up of Nsukka Local Government Area L.G.A.(30 schools), Uzo-Uwani L.G.A (12 schools), and Igbo-Etiti L.G.A.(16 schools). The total number of schools is 58. The choice of the Zone is based on the fact that the Zonal Inspector of Education commented that the Zone had not being doing well in chemistry. The choice of this L. G. A. is based on the fact that it has the highest number of government owned secondary schools (32 out of 59) and most schools have similar number of facilities in terms of equipment, staff strength, staff qualifications etc. this will give enough room for random selection of the samples.

**Population of the Study**

All the senior secondary chemistry two (SS2) chemistry students in all the government owned secondary schools in Nsukka Education Zone forms population of the study. The choice of SS2 chemistry students is because the organic chemistry to be taught is in their scheme of work and also they are not in examination class.

**Sample and sampling technique**

The sample consisted of 435 students comprising 220 students for experimental group and 215 for control group. Simple random sampling technique was used in selecting one local government area out of the three L. G. As' in Nsukka education zone. Following this, Nsukka L.G.A was picked. Purposive sampling

 

technique was used in selecting two schools from the L.G.A. Purposive sampling technique was used in order to pick four single sex schools with common characteristics such as well equipped laboratory, experienced chemistry teacher and two intact streams. Simple random sampling technique was used to assign classes to experimental and control groups.

**Instrument for data Collection**

The instrument used for this study is Achievement and Retention Test in organic chemistry (ARTOC). The instrument was adopted from Ezendu (1995). The instrument was face validated by three experts. Table of specifications was made and psychometric characteristics of the items were analyzed using item facility (IF), item discrimination (DI) and distractor index (DIS), ( Ezendu, 1995). The reliability of the instrument was done using Kudder-Rechurdon (K-R) formula 20 and the value was 0.86. Lesson plans for both the experimental and the control groups were used for the study.

**Experimental Procedure**

The experimental procedure began with the training of the chemistry teachers in both schools. This took place during the mid-term break of the school which lasted for one week. The teachers were trained on use of two teaching methods as well as in the research conditions. Also the contents, objectives and activities of the students were discussed during the training. The two teaching methods are the same in terms of their content, instructional objectives and evaluations. The students were pre-tested before the teaching. The experiment lasted for four weeks after which the post-test was administered to two groups. The scores for both tests were collected and the teachers marked the scripts.

**Control of Extraneous Variable**

To reduce error which might arise as a result of teacher differences, all the four chemistry teachers that were used for the study were the regular class teachers in the schools. The teachers will teach both the experimental and the control group in each school. All the teachers were given the same lesson plans to maintain uniformity. The lesson plans were extensively discussed during the training under the supervision of the researcher.

**Intergroup Variable**

In order to eliminate the errors of non equivalence arising from non-randomization of the research subjects, analysis of covariance (ANIOVA) was used in analyzing the data and to remove error of initial differences in ability levels among the research subjects.

**Experimental bias:** The teaching for both experimental and control groups was not done by the researcher but by the regular class teachers. This was to avoid Hawthorns effect.

**Teacher variable:** The chemistry teachers taught the students in their normal classrooms and laboratories. There was training programme for the teachers. During the period, the validated lesson plans for both the experimental and the control groups were discussed between the teachers and the researcher. The researcher gave the teachers common instructions. There were trial teachings by the teachers and the researcher watched and corrected them. All these were to ensure uniformity.

**Class interaction:** All the students received the lessons in their respective normal classrooms. The researcher instructed the teachers not to give notes or assignments to the students so as to avoid exchange of ideas outside the classroom.

**Effects of pretest on posttest**: The pretest and posttest administration gap was four weeks and the period was long enough not to permit pretest to affect posttest scores and also to prevent students from becoming familiar with test items.

**Initial Group Difference:** It was not possible to do complete randomizations; intact classes were randomly assigned to treatment conditions. Also Analysis of Variance (ANCOVA) was used to bridge the gap of non-equivalence of the intact classes.

**Method of data Analysis:** Mean and standard deviation scores were used to answer the research questions while analysis of covariance (ANCOVA) was used to test the hypotheses at the 0.05 alpha levels. Analysis of covariance ANCOVA was used to serve as a controller for the initial differences across the groups as well as increasing the precision due to the extraneous variables thus reducing error variance.

## RESULTS

The results of the study is presented below. The data obtained from the administration of ARTOC for testing achievement of students and Post ARTOC for testing the retention of the students were analyzed according to the research questions and hypothesis.

 

**Table 1:** Multivariate analysis result between covariates and corresponding dependent variables.

| Effect | | Value | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|---|---|
| Intercept | Pillai's Trace | .602 | 324.184[a] | 2.000 | 429.000 | .000 |
| | Wilk.s Lambode | .398 | 324.184 [a] | 2.000 | 429.000 | .000 |
| | Hotelling.s Trace | 1.511 | 324.184 [a] | 2.000 | 429.000 | .000 |
| | Roy.s Largest Root | 1.511 | 324.184 [a] | 2.000 | 429.000 | .000 |
| Pretestscore | Pillai's Trace | .380 | 131.638 [a] | 2.000 | 429.000 | .000 |
| | Wilk.s Lambode | .620 | 131.638 [a] | 2.000 | 429.000 | .000 |
| | Hotelling.s Trace | .614 | 131.638 [a] | 2.000 | 429.000 | .000 |
| | Roy.s Largest Root | .614 | 131.638 [a] | 2.000 | 429.000 | .000 |
| Group | Pillai's Trace | .859 | 1304.004 [a] | 2.000 | 429.000 | .000 |
| | Wilk.s Lambode | .141 | 1304.004 [a] | 2.000 | 429.000 | .000 |
| | Hotelling.s Trace | 6.079 | 1304.004 [a] | 2.000 | 429.000 | .000 |
| | Roy.s Largest Root | 6.079 | 1304.004 [a] | 2.000 | 429.000 | .000 |
| Gender | Pillai's Trace | .014 | 3.069 [a] | 2.000 | 429.000 | .047 |
| | Wilk.s Lambode | .986 | 3.069 [a] | 2.000 | 429.000 | .047 |
| | Hotelling.s Trace | .014 | 3.069 [a] | 2.000 | 429.000 | .047 |
| | Roy.s Largest Root | .014 | 3.069 [a] | 2.000 | 429.000 | .047 |
| Group• Gender | Pillai's Trace | .048 | 10.831 [a] | 2.000 | 429.000 | .000 |
| | Wilk.s Lambode | .952 | 10.831 [a] | 2.000 | 429.000 | .000 |
| | Hotelling.s Trace | .050 | 10.831 [a] | 2.000 | 429.000 | .000 |
| | Roy.s Largest Root | .050 | 10.831 [a] | 2.000 | 429.000 | .000 |

This table presents the test of the assumptions of the analysis of covariance between the covariates and the corresponding dependent variables and the homogeneity of variance. The pretest score showed a significant ($P < 0.00$) relationship between the covariates and the corresponding dependent variables. This means that both the experimental and control groups were equal at the start of the experiment.

**Research Question 1**

What is the students' means achievement scores and mean retention scores in organic chemistry when taught with concept maps and lecture method?

**Table 2:** Means and Standard Deviation scores of students' post achievement scores.

| | Group | Gender | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Posttest Score | Experimental | Male | 71.5913 | 7.38050 | 115 |
| | | Female | 67.8286 | 7.76265 | 105 |
| | | Total | 69.7955 | 7.77944 | 220 |
| | Control | Male | 44.4095 | 7.31791 | 105 |
| | | Female | 45.1818 | 5.73446 | 110 |
| | | Total | 44.8047 | 6.55166 | 215 |
| | Total | Male | 58.6182 | 15.45828 | 220 |
| | | Female | 56.2419 | 13.22053 | 215 |
| | | Total | 57.4437 | 14.42838 | 435 |
| Retention Score | Experimental | Male | 71.6000 | 7.50532 | |
| | | Female | 67.8286 | 7.60624 | |
| | | Total | 69.8000 | 7.76928 | |
| | Control | Male | 41.3429 | 6.48642 | |
| | | Female | 43.0273 | 6.40879 | |
| | | Total | 42.2047 | 6.48686 | |
| | Total | Male | 57.1591 | 16.68570 | |
| | | Female | 55.1395 | 14.26351 | |
| | | Total | 56.1609 | 15.55626 | |

Where N is the number of subjects

The experimental group taught with concept maps had achievement mean scores of 69.80 with a standard deviation of 7.78 while the control group taught with lecture method had a mean score of 44.81 and standard deviation of 6.55. It can be seen that the experimental group achieved better than the control group.

 

Also from the table 2, the experimental group had a retention mean score of 69.80 with the standard deviation of 7.77 and the control group had a retention mean score of 42.21 and the standard deviation of 6.49. It then follows that the experimental group retained higher than the control group on the organic chemistry concepts taught to them. In order to take a decision on this, hypothesis one was tested.

**Hypothesis One**

There is no significant difference between the mean achievement scores and mean retention scores of students' taught with concept maps and those taught with lecture method.

**Table 3:** Summary of analysis of covariance (ANCOVA) results of students' Post-test scores and Retention scores.

| Source | Dependent Variable | Type 111 sum of Squares | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Corrected Model | Posttest Score | 76941.528 | 4 | 19235.382 | 612.984 | .000 |
| | Retention Score | 89356.204 | 4 | 22339.051 | 616.894 | .000 |
| Intercept | Posttest Score | 18118.194 | 1 | 18118.194 | 581.065 | .000 |
| | Retention Score | 21008.359 | 1 | 21008.359 | 576.470 | .000 |
| Pretest score | Posttest Score | 8222.618 | 1 | 8222.618 | 263.706 | .214 |
| | Retention Score | 5620.558 | 1 | 5620.558 | 154.228 | .153 |
| Group | Posttest Score | 71632.249 | 1 | 71632.249 | 2297.302 | .000 |
| | Retention Score | 85915.486 | 1 | 85915.486 | 2357.524 | .000 |
| Gender | Posttest Score | 180.779 | 1 | 180.779 | 5.798 | .016 |
| | Retention Score | 82.970 | 1 | 82.970 | 2.277 | .132 |
| Group • Gender | Posttest Score | 518.935 | 1 | 518.935 | 16.643 | .000 |
| | Retention Score | 768.662 | 1 | 768.662 | 21.092 | .000 |
| Error | Posttest Score | 13407.842 | 430 | 31.181 | | |
| | Retention Score | 15670.532 | 430 | 36.443 | | |
| Total | Posttest Score | 1525752.000 | 435 | | | |
| | Retention Score | 1477038.000 | 435 | | | |
| Corrected Total | Posttest Score | 90349.370 | 434 | | | |
| | Retention Score | 105026.736 | 434 | | | |

The post-test score of the group has a mean square of 71632.25 and the retention scores of the group has a mean square of 85915.49. These indicated significant ($P < 0.00$). The decision then is to reject the hypothesis. This, therefore, implied that there was a significant difference between the mean achievement scores and mean retention scores of students taught with concept maps and those taught with lecture method.

**Research Question 2**

What influence has gender in students' mean achievement scores and mean retention scores in organic chemistry when taught with concept maps or with lecture method?

In table 3 above, males in experimental group based on the post-achievement scores had a mean of 71.59 and a standard deviation of 7.38 while the females had a mean of 67.83 and a standard deviation of 7.76. It means that with the experimental group, the males achieved better than the females. In the control, the males had a mean of 44.41 and a standard deviation of 7.32 while the females had a mean of 45.18 and a standard deviation of 5.74. So with the control group, the females did better than the males.

From the table 3 above based on the retention scores, the males in the experimental group had a mean of 71.60 and a standard deviation of 7.51 while the females had 67.83 and a standard deviation of 7.61. So the males retained the organic chemistry more than the females. In the control, group, and taken the retention scores, the males, had a mean of 41.35 and a standard deviation of 6.49 while the females had a mean of 43.03 and a standard deviation of 6.41. Here the females retained the organic chemistry taught to them more than the males. A better decision can be taken by looking at hypothesis 2.

**Hypothesis 2**

Gender will not be significant factor in mean achievement scores and mean retention scores of students' taught organic chemistry with concept maps and those taught with lecture method.

Looking at table 3 above, the post-test score of gender had a mean square of 180 .78 for the achievement. This indicated not significant (0.016). Also from the table for the retention, gender had a mean square of 82.97 which also indicated not significant (0.132). These means that the hypothesis is accepted. Which means that there is no significant difference in the mean achievement scores and mean retention scores of students' taught organic chemistry. With concept maps and those taught with lecture method based on gender.

 

That is the male and female students' achieved and retained the organic chemistry equally when taught using the two methods.

**Research Question 3**

How will concept maps and lecture method interact with gender to influence students' achievement and retention in organic chemistry?

**Table 4:** Interaction of group by gender

| Dependent Variable | Group | Gender | Mean | Std. Error | 95% Confidence interval | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| Posttest Score | Experimental | Male | 71.900 | .521 | 70.876 | 72.924 |
| | | Female | 68.423 | .546 | 67.350 | 69.497 |
| | Control | Male | 43.981 | .546 | 42.818 | 44.964 |
| | | Female | 44.786 | .533 | 43.739 | 45.834 |
| Retention Score | Experimental | Male | 71.855 | .563 | 70.748 | 72.962 |
| | | Female | 68.320 | .590 | 67.160 | 69.480 |
| | Control | Male | 40.914 | .590 | 39.754 | 42.074 |
| | | Female | 42.700 | .576 | 41.568 | 43.833 |

Taken the achievement scores, the male students' taught with concept maps had a mean of 71.90 while the female students also taught with concept maps had a mean of 68.42. So concept maps interaction with gender has more effect on the male student than on the female students.

Also in the achievement scores the males though with lecture method has a mean of 43.89 while the females had a mean of 44.79. So the lecture method interaction with gender was more effective on the females than on the males. Taken the retention scores, the males taught with concept maps had a mean of 71.86 while the females taught with concept maps had a mean of 68.32. 59. So interaction of concept maps and gender was more effective with the males than the females. Also in the retention scores, the males taught with lecture method. had a mean of 40.91 while the females had 42.70. And so interaction of lecture method and gender was more effective on the females than on the males. A look at the hypothesis 3 will help in taken decision on this further.

**Hypothesis 3**

There will be significant interaction between concept maps and lecture method with gender on students' achievement and retention in organic chemistry. Table 3 above indicated group • gender and it shows that post achievement mean square of 518.94 and it was significant (0.00) and Retention mean square of 768.66 and it was significant (0.00). The hypothesis is rejected and this implies that there was a significant interaction effect between gender• groups and methods on the students' achievement and retention in organic chemistry. It means that the effects of the methods and gender groups influenced the students' academic achievement and retention in organic chemistry.

**Summary of the Results**

1. Both the experimental and the control groups were equal at the start of the experiment.
2. The experimental groups achieved and retained the organic chemistry more than the control groups.
3. The male and female students achieved and retained the organic chemistry equally.
4. The methods and gender influenced the achievement and retention of the students in organic chemistry.

**Discussion of the Results**

The results on table 2 revealed that the students taught using concept maps scored higher in organic chemistry (Mean = 69.80) than those taught with lecture method (mean = 44.81). The experimental and control groups had equal mean scores prior to treatment.

The above finding is in agreement with that of Jedede, Alaiyemola and Okebukola 1990; and Roth and Roychoudhury (1993). The results on table 2 showed that the experimental group had a higher retention score (Mean = 69.80) than the control group (Mean 42.21). This result is in agreement with Ezeh 1992.

The result of this study is in line with the assertion of Ausubel in his cognitive theory of learning, that concepts are learned not by rote but by meaningful learning. The results on table 2, revealed that the difference between the mean achievement scores of male students (71.59) acid that of the female students (67.83) and in the

 

retention scores of the male students (71.60) and that of the female students (67.83) in the experimental group is closely marginal though in favour of the male students. The results shown on the ANCOVA table (table 3 indicated that the difference was not significant).

This showed that gender was not a significant factor in students' achievement and retention with Nzewi (2010, 2011), Okeke (2007), Based (2006) and Onimis (2006). This result is not in agreement with Agomaoh (2010), Ukozor (2011) and Iweka (2006), Obiekwe (2008) who reported that boys achieved better than girls and vice versa respectively.

Table 4 showed that the male students taught using concept maps scored higher (71.90) than the male students taught with lecture method (43.89) in achievement. While in retention, the male students taught with concept maps also scored higher (71.86) then the male students taught with lecture method (40.91). The female students taught with concept maps scored higher (68.42) than the female students taught with lecture method (44.79). On the retention scores, the female students taught concept maps scored higher (68.32) than the female students (42.70) taught with lecture method.

Table 3 showed that the interaction of method and gender on achievement and retention was significant. Therefore, it implied that the use of concept maps had relative effects on achievement and retention of male and female students taught with concept maps that those taught with lecture method.

**Recommendations**

1. Chemistry teachers should be encouraged to adopt the use of concept maps in teaching and learning of organic chemistry in particular and chemistry in general.
2. Chemistry teachers should be encouraged to adopt concept maps as a means of eliminating gender related differences in the classroom.
3. Effocts should be made to equip serving chemistry teachers with requisite knowledge, skills and competencies on the production and use of concept maps. This can be done through organizing seminars, workshops, conferences etc.
4. Concept maps and their uses should be incorporated into the senior secondary school chemistry curriculum. This will enable the teachers to apply them appropriately to teach chemistry.
5. Teacher education programmes in colleges of education and universities should be made to inculcate in the students the processes of production and use of concept maps in teaching chemistry.

**Conclusion**

The conclusions based on the results of this study are as follows: The use of concept maps had a significant effect on the students' achievement and retention in organic chemistry. The use of concept maps was, therefore, more effective than the lecture method for teaching organic chemistry.

Gender was not a significant factor on the students' achievement and retention in organic chemistry. The male and female students' therefore, showed the same level of achievement and retention in organic chemistry using concept maps.

The combined effects of method and gender on achievement and retention in organic chemistry were significant.

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