EFFECT OF CONCEPT-MAPPING INSTRUCTIONAL STRATEGY ON SECONDARY SCHOOL STUDENTS' INTEREST AND ACHIEVEMENT IN GEOMETRY IN BICHI EDUCATIONAL ZONE, KANO STATE, NIGERIA

By

[1]John E. Eze Ph.D & [2] Cletus I. Madu Ph.D

[1&2]Department of Mathematics

Federal College of Education (Technical), Bichi,

Kano state

Abstract

This study investigated the effects of concept- mapping instructional strategy on secondary school students' interest and achievement in geometry. The major objectives of the study were to: find out the effect of concept mapping instructional strategy on the academic achievement and interest of students, find out the differential effect of concept-mapping instructional strategy on academic achievement and interest of male and female students and find out the interaction effect of concept mapping instructional strategy and gender on students' academic achievement in geometry. This study adopted a quasi-experimental research design namely a non-equivalent pretest-posttest control group research design in which intact classes were randomly assigned to the experimental and control groups. A sample of three hundred and ten (310) students was drawn from four single sex senior secondary schools in Bichi Educational Zone of Kano State. Specifically, the sample was made up of 170 males and 140 females from the selected schools. Four research questions and five hypotheses were formulated to guide the study. The instruments used for data collection during the pre-test and post-test consisted of a geometry achievement test (GAT) and geometry interest scale (GIS). The GAT consisted of 50 multiple choice questions and 6 essay type questions on circle theorems, bearings, sine and cosine rules while the GIS consisted of 25 items questionnaire on interest towards mathematics generally and geometry in particular. The GAT was validated by specialists in mathematics education and measurement and evaluation using table of specifications constructed for the multiple choice and essay tests. The multiple choice test had average difficulty and discrimination indices of 0.39 and 0.52 respectively. The reliabilities of the multiple choice test items and geometry interest scale were established using the coefficient of internal consistency based on Cronbach Alpha (α).The reliability coefficients for the GAT and GIS were 0.64 and 0.73 respectively. The data collected from the pre-test and post-test were subjected to statistical analysis using the Statistical Package for Social Sciences (SPSS) version 22.0. The research questions were answered using descriptive statistics while the hypotheses for the study were tested using t-test statistics and the Analysis of Covariance (ANCOVA) with pre-test scores as covariates at 0.05 level of significance. The findings from the study showed that: concept- mapping instructional strategy was more effective than the conventional method in improving students' academic achievement and interest in geometry, there was no significant difference between the achievement of male and female students from the experimental group in geometry and there was a significant difference in the achievement in the interest of male and female students in geometry. It was recommended among others

that curriculum developers should incorporate concept-mapping instructional strategy in curriculum guidelines to enrich the methodology and content of mathematics for effective instructional delivery.

Key words: Concept-mapping, Interest, Achievement, Geometry& Instructional strategy

Background to the Study

Mathematics is the branch of science which involves the use of numbers and their operations in calculating, computing and solving problems. Mathematics is a core subject from primary school to post- primary school levels of the Nigerian educational system (FGN, 2013). This important position occupied by the subject in the school curricula are borne out of the role of mathematics in science and technological development. A good foundation in mathematics is the basic requirement for development of a nation. Mathematics is the central intellectual discipline of the technological societies. Scientific ideas and findings are communicated into the world of works using mathematical terminologies. Thus, mathematics is the bed rock of science and technology, which is the springboard of national development. The increasing importance and attention given to mathematics stem from the fact that without mathematics, there is no science, without science, there is no modern technology and without modern technology, there is no modern society. In other words, mathematics is the precursor and the queen of science and technology and indispensable single element in modern societal development (Eguavon, 2002).

Geometry is one of the branches of mathematics concerned with the visual study of shape, size, relative position of figures and the properties of space (Ibrahim & Busari, 2016). Geometry developed from a need to compute angles and distances in such fields as astronomy, map making, surveying, and artillery range finding. Geometry has applications to every facet of human endeavour. The techniques in geometry are used for finding relevance in navigation particularly satellite systems and astronomy, naval and aviation industries, oceanography, land surveying, and in cartography (creation of maps). It is in recognition of the importance of geometry in particular and mathematics in general that it is studied as a compulsory subject at both primary and secondary school levels so that every school child will acquire appropriate scientific and mathematical knowledge and skills.

Despite the significant place of mathematics in the technological development of any nation, the teaching and learning of geometry in particular and mathematics in general are great challenge to both the teachers and the students. In secondary schools, students that were taught geometric concepts like sines, cosines, tangents and cotangents have difficulties associating them with real life situations (Kacar & Tuna, 2013). If the formation, the association with real life situations and the importance of using these concepts are explained to students, these concepts may be learned better.

There has been an increasing mass failure in mathematics as a subject in most external examinations such as West African Examination Council (WAEC) (Chief Examiner's Report, 2015). The Chief Examiner's report revealed that the percentages of students who failed to obtain a credit pass in mathematics at the senior secondary certificate

examination was due to their poor attempt at all the geometric related questions. This poor achievement could be attributed to students' poor mathematics background, teaching methodology, large number of students in the classroom and many other reasons. Thus, the issue of poor achievement in geometry in particular and mathematics in general is not only a source of concern to students but also a challenge to teachers. In order for students to master and understand the mathematics concepts especially geometry, there must be wide spread changes in the teaching strategies that would promote students' understanding of mathematics.

Research evidence from Zakaria and Iksan (2007) indicated that mathematics today still follows the traditional acquisition of knowledge. In such an environment, students become passive recipients of knowledge and resort to rote learning. The majority of work involves teacher using expository teaching method or simple question and answer that demand basic recall of knowledge from the learners. Zakaria and Iksan noted that this traditional pattern of teaching mathematics has been identified as being ineffective and as one major factor responsible for the poor achievement of students in mathematics. Thus there is need to find methods and techniques to make learning more meaningful so as to improve students achievement, especially in geometry. . One way of achieving this may be through the adoption of student-centered, activity-based and minds-on approaches that cater for individual needs and differences, learning styles, interests and abilities. One such student centred, inquiry-based approach to organize learning is concept- mapping.

Concept- mapping, according to Canas and Novak (2006) is a graphical arrangement of key concepts to show meaningful relationships among the selected concepts or ideas being studied. The development of this strategy was based on Ausubel's assimilation theory, which in turn is based on the principle that the single most important factor influencing learning is what the learner already knows. It relates directly to such theoretical principles as prior knowledge, subsumption, progressive differentiation, cognitive bridging and integrative reconciliation.

Some researchers such as (Ajaja, 2011; Bot & Eze, 2016) investigated the effectiveness of the concept -mapping instructional strategy on different subjects' areas. The results showed a significant increase in test scores of students who used concept- mapping as a study skill.

Students' poor achievement in mathematics could also be attributed to their low interest in the subject. Interest could also be described as a disposition and feelings of an individual towards an activity, which shows behaviorally the extent the person likes to participate in the activity. Generally, there is low interest in the study of mathematics and mathematics- related disciplines at all levels of education in Nigeria. In most secondary schools, students absent themselves in mathematics and those who stay in the lesson pay little attention to their teachers. This, consequently, will lead to their poor achievement in both internal and external mathematics examinations, which invariably increases student's hatred for mathematics and mathematics related courses.

The purpose of this study therefore was to find out the effect of concept- mapping instructional strategy on senior secondary school students' interest and achievement in geometry. The study also sought to determine the extent to which the use of hierarchical

concept- mapping instructional strategy affects the interest and achievement of male and female students in geometry.

Statement of the Problem

The major goal of secondary mathematics education as derived from the National Policy on Education (FGN, 2013) is to generate interest in mathematics and provide a solid foundation for everyday living. Stemming from this goal is the teacher's mandate to teach the students effectively, but it is disheartening that the teaching and learning of geometry in particular and Mathematics in general has been faced with challenges which results in students poor achievement.

Some researchers such as (Onyishi & Agwagah, 2011; Adewumi, 2012) have attempted to find out some of the causes of poor achievement of students in mathematics. Research results reveals that the method presently in use by the teachers of mathematics are traditional talk or lecture rather than strategies that involves participation. As a result, students achieve poorly in mathematics. This is because the students have great difficulty in understanding and assimilating the mathematics taught to them in the classroom. They neither understand the basic computation, logic, fundamental principles nor does the underling process that result to mathematical facts.. Various teaching methods such as problem solving, discovery, discussion, cooperative and concept mapping have been developed to take care of situations like this, but mathematics teachers rarely make use of some of them. This may be as a result of their ignorance or their choice to remain glued to the traditional talk or lecture methods which they feel are simple. Thus, the observed poor achievement in mathematics in general and geometry in particular requires an effective teaching strategy.

The problem of poor achievement in mathematics especially as it affects gender constitute a problem in the school system considering the fact that mathematics is very important and everybody needs it for the purpose of creating meaningful development. A number of studies have verified the influence of gender on mathematics achievement of students (Jahun & Momoh, 2001; Etukudo, 2002; Eniayeju, 2010). Other research findings have debunked the idea of sexual differentiation in ability (Gbodi & Laleye, 2006). This had led to series of divergent views on the influence of gender on the mathematics interest and achievement of students'. These divergent findings necessitated the present study with a view to finding support to the actual situation in Nigeria. The search for a good instructional delivery process that could balance the gender inequality in mathematics cannot therefore, be over-emphasized.

The focus of this study therefore is to examine the extent to which the use of concept-mapping instructional strategy affect the interest and achievement of secondary school students in geometry; to determine the extent to which the use of concept mapping affects the achievement of male and female students in geometry.

Objectives of the Study

The major objective of this study is to determine the effect of concept- mapping instructional strategy on secondary school students' interest and achievement in geometry in Bichi Educational Zone, Kano State.

Specifically, the study sought to:

1. Analyze the effect of concept-mapping instructional strategy on students' achievement in geometry.
2. Find out the effect of concept -mapping instructional strategy on the achievement of male and female students' in geometry.
3. Determine the effect of concept- mapping instructional strategy on students' interest rating in geometry.
4. Compare the effect of concept- mapping instructional strategy on the interest rating of male and female students' in geometry.
5. Find out the interaction effect of gender on method as measured by geometry achievement test (GAT).

Research Questions

The following research questions were formulated to guide the study.

1. What is the effect of concept-mapping instructional strategy on students' post-test geometry achievement test?
2. What is the effect of concept-mapping instructional strategy on the achievement scores of male and female students' in geometry?
3. What is the effect of concept-mapping instructional strategy on the students' post-test mean interest rating in geometry?
4. What is the effect of concept -mapping instructional strategy on the level of interest of male and female students' in geometry?

Hypotheses

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

1. There is no significant main effect of treatment (concept-mapping & conventional) on senior secondary school students' achievement in geometry.
2. There is no significant main effect of gender on senior secondary school students' achievement in geometry.
3. There is no significant interaction effect of treatment and gender on senior secondary school students' achievement in geometry.
4. There is no significant main effect of treatment on senior secondary school students' interest in geometry.
5. There is no significant main effect of gender on senior secondary school students' interest in geometry

Research Methodology

Research design

This study adopted a quasi-experimental research design. Specifically, the study adopted the non-equivalent pretest-posttest research design in which intact classes were assigned to the experimental and control groups. This study is quasi experimental because there was no randomization of subjects. The quasi-experimental design was used to empirically estimate the causal impact of an intervention on its target population.

Population, Sample and Sampling Techniques

The population of the study consisted of all senior secondary two (SSII) students in 29 public senior secondary schools in Bichi Educational Zone of Kano State.

The sample for the study consisted of three hundred and ten (310) Students (170 males and 140 females) drawn from 4 public senior secondary schools in Bichi Educational zone of Kano state. Each school has three arms or classes and had presented students for senior Secondary Certificate Examinations..

Multi-stage sampling technique was used to select a representative sample of four schools from two local government areas in Bichi Educational zone. The choice of multi-stage sampling technique was to select clusters that are not only as heterogeneous as possible but also to reduce the sampling error in the study.

Instruments for Data Collection

Two instruments were used for the study. They are: the Geometry Achievement test (GAT) which was used for the pre-test and the post-test and the Geometry Interest scale (GIS) which was also used for the pre-test and post- test.

The GAT instrument was developed by the researcher while GIS instrument was a modified instrument adapted from Alio & Harbor-Peters (2000). The GAT consists of 50 multiple- choice questions and 6 essay- type questions developed by the researcher from the topics, Circle theorems, Bearings, Sine and Cosine rules. The GAT consisted of Section A which sought for general information about respondents such as Name, Age, Gender and number in the class while section B comprised of multiple choice questions and section C was made up of the Essay questions. The items of GAT were developed using lower and higher order questions. The lower order questions covered knowledge and comprehension of the cognitive domain while questions involving higher thinking processes covered application and analysis.

The geometry interest scale was the 25 items questionnaire that were used to get the students' feelings towards mathematics generally and geometry in particular. It consisted of two sections. Section A seeks for general information about respondents such as Name, Age, Gender and number in the class while section B was based on their interest in geometry. Each of the items is a modified 4-point likert type rating scale. The options are: Strongly agree (SA), Agree (A), Disagree (D), Strongly disagree (SD) rated, 4, 3, 2 and 1 for positive statements and 1,2,3,4 for all negative statements

Two sets of lesson plans developed by the researcher were used for the study. One of the lesson plans was developed using concept-maps. This was used to teach the experimental group .The second was the lesson plan which was developed in line with the conventional teaching method was used to teach the control group.

Table of specifications for the objective and essay tests was constructed for the development of these instruments. The instruments were developed based on the topic and objectives of SSII mathematics curriculum on geometry (Circle theorems, Bearings, Sine and Cosine rules)

Validation of the Instruments

The geometry achievement test (GAT) items and geometry interest scale (GIS) were validated by two experts in measurement and evaluation and one in mathematics education.

The researcher validated the instruments by subjecting each to scrutiny of experts. The independent corrections, observations and comments made by these experts were incorporated into the final form of the instruments.

Reliability of the Instruments

The reliability of the multiple choice test items and geometry interest scale were established by using the coefficient of internal consistency based on Cronbach Alpha (α). The reliability coefficients for the GAT and GIS were 0.64 and 0.73 respectively.

The difficulty and discrimination indices of the multiple choice questions were computed. The reliability of the Essay test was established by using test- retest method. The reliability coefficient was computed using Pearson Product moment correlation Coefficient. The Essay test has a reliability coefficient of 0.76.

Administration of Treatment

Before the commencement of the main treatment, the subjects in both the experimental and the control groups were given the pre-treatment test to determine the equivalence of the groups as to achievement in geometry. The pretest scores were used as covariates to take care of lack of initial equivalence in the groups since intact classes were used for the study.

The effectiveness of the concept- mapping instructional strategy was determined after treatment. This was obtained from students' interest and achievement on GAT and GIS. The experimental group was taught the concepts of circle theorems, bearings, sine and cosine rules using the concept- mapping instructional strategy by the research assistants (Mathematics teachers). The teaching was done using lesson plans prepared by the researcher. This treatment lesson plans were used to teach the experimental group for a period of 8 weeks. During the treatment, relevant instructional materials and pre-activity questions were provided to the students. Instructional materials were provided to ensure that students are not just a passive listener but are actively involved in the lesson.. The lesson was supervised by both the researcher and Head of Mathematics Department in the schools used for the study to ensure that the research assistants follow strictly the lessons as planned**.** This was done using observational rating scale to indicate the teachers' levels of compliance in implementing the lesson as planned.

The students' in the control group were taught the concepts of circle theorems, bearings, sine and cosine rules using the conventional teaching method. The 4 trained teachers taught students the same content areas using the validated lesson plans prepared by the researcher as a guide for the period of 8 weeks. The post-test was administered to both the experimental and the control groups at the end of the experiment. The administered GAT was collected and later marked and scored by the researcher.

Data Analysis and Results

The scores from the pretest and posttest were subjected to statistical analysis using the Statistical Package for Social Sciences (SPSS). Research questions (1-4) were analyzed using descriptive statistics. Hypotheses (1-3) were tested using the Analysis of Covariance (ANCOVA) with the pre-test scores as covariates at 0.05 significance level. Analysis of Covariance (ANCOVA) was used to take care of lack of initial equivalence in the groups since intact classes were used for the study. Hypotheses (4 and 5) were tested using the independent sample t-test statistic in order to determine if there was a statistically significant difference in the mean interest rating scores of students'. The results of the study are presented in the tables below.

Research question one

What is the effect of concept- mapping instructional strategy on students' post-test geometry achievement test?

Table 1: Pre-test and Post-test Mean Achievement Scores of Students in the Experimental and Control Group

Group	Type of test	N	Mean	S.D	Mean gain
Experimental	PRE-GAT		18.90	6.03	
	POST-GAT	158	61.30	14.06	42.40
Control	PRE-GAT		17.80	5.85	
	POST-GAT	152	46.10	14.80	28.30

This result shows that the mean gain in experimental group and control group were 42.40 and 28.30 respectively. These results show that the students in the experimental group improved upon their geometry achievement scores than the students in the control group as shown by their higher difference in the mean scores.

Research question two

What is the effect of concept- mapping instructional strategy on the achievement scores of male and female students' in geometry?

Table 2: Mean Achievement Scores of PRE-GAT and POST-GAT of Male and Female students in the Experimental group

Gender	Type of test	N	Mean	S.D	Mean gain
Male	PRE-GAT		19.20	8.52	
	POST-GAT	88	60.20	14.80	41.00
Female	PRE-GAT		19.70	7.08	
	POST-GAT	70	59.40	13.20	39.70

Table 2 shows the results on the achievement of male and female students in PRE-GIS and POST-GIS in experimental group. The post-test mean score of the male and female students in the experimental group were 60.20 and 59.40 respectively. The mean gain

of the male students (41.00) was better than the females (39.70) in the experimental group.

Research Question three

What is the effect of concept-mapping instructional strategy on the students' post-test mean interest rating in geometry?

Table 3: Mean Interest Rating Scores of Students in Experimental and Control Groups in Geometry Interest Scale

Group	N	Type of test	Mean	S.D	Mean gain
Experimental	158	PRE-GIS	25.71	2.32	
		POST-GIS	51.76	6.11	26.05
Control	152	PRE-GIS	25.39	2.38	19.18
		POST-GIS	44.57	4.34	

The result in table 3 shows that the difference between the Pre-GIS and Post-GIS of students in control and experimental groups were 19.18 and 26.05 respectively. This implies that students taught using concept-mapping instructional strategy improved their interest in geometry than their counterpart in conventional teaching method.

Research Question four

What is the effect of concept- mapping on the mean interest rating of male and female students in geometry?

Table 4

Mean Interest Rating Scores of PRE-GIS and POST-GIS of male and female Students' in the Experimental Group

Gender	Type of test	N	Mean	S.D	Mean gain
Male.	PRE-GIS		21.23	6.48	
	POST-GIS	88	52.80	9.37	31.57
Female	PRE-GIS		22.81	7.02	
	POST-GIS	70	41.17	7.81	18.26

Table 4 shows that the PRE-GIS mean scores of the male was 21.23 while that of the female was 22.81. The POST-GIS mean scores of male and female was 52.80 and 41.17 respectively. The mean gain of the male students (31.57) was higher than the female (18.26).

Hypotheses 1, 2 and 3

Data for testing research hypotheses 1, 2 and 3 are presented in Table 5.

HO_1. There is no significant main effect of treatment (concept-mapping & conventional teaching method) on senior secondary school students' achievement in geometry.

HO_2. There is no significant main effect of gender on senior secondary school students' achievement in geometry.

HO_3. There is no significant interaction effect of treatment and gender on senior secondary school students' achievement in geometry.

Table 5: Two Way ANCOVA for difference in Achievement of Students' based on Gender and Method

Sources of variation	Sum of squares	Df	Mean squares	F value	Sig. of F	Partial Eta Squared
Corrected model	11442.418[a]	4	2860.604	46.576	0.000	.713
Intercept	358.849	1	358.849	5.843	0.018	.072
Pre-GAT	7193.462	1	7193.462	117.123	0.000	.610
Method	429.328	1	329.328	6.990	0.010	.083
Gender	165.709	1	165.709	2.698	0.102	.035
Method* Gender	53.972	1	53.972	0.879	0.352	.012
Error	4606.332	295	61.418			
Total	2482500.000	310				
Corrected Total	16048.750	309				

a. $R^2 = 0.713$ (Adjusted R squared = 0.610), S = significant, NS = not significant

Table 5 shows that there is a significant main effect in the mean achievement scores of students' taught geometry by concept- mapping instructional strategy and those taught by the conventional method, since $F_{(1, 295)} = 6.990$, $p = 0.001 < 0.05$ and $\eta^2 = .085$

Hypothesis 1 which states that there is no significant main effect of treatment (concept-mapping & conventional teaching method) on senior secondary school students' achievement in geometry is rejected. Thus students taught geometry using concept - mapping instructional strategy significantly improved in their mean achievement scores than students taught with conventional method.

Table 5 also shows that there was no significant main effect of gender on senior secondary school students' achievement in geometry since, $F_{(1.295)} = 2.698$, $P = 0.102 > 0.05$ and $\eta 2 = .035$. This means that male students did not achieve significantly better than their female counterpart in geometry content. Thus, hypothesis 2 which states that there is no significant main effect of gender on senior secondary school students' achievement in geometry was therefore upheld.

In testing for hypothesis 3, Table 5 equally shows that gender did not interact significantly with method to influence students' achievement, since $F_{(1,295)} = 0.879$, $P = 0.352 > 0.05$ and $\eta^2 = .0\ 12$. Thus hypothesis 3 which states that there is no significant interaction effect of treatment and gender on senior secondary school students' achievement in geometry was also upheld.

Hypotheses 4

Data for testing the research hypothesis 4 is presented in table 6.

HO_4: There is no significant main effect of treatment on senior secondary school students' interest in geometry.

Table 6: t-test comparison of the post-test mean interest scores of students' in the experimental and control group

Group	N	Mean	S.D	Df	t-value	p-value	Decision
Experimental	158	51.76	6.11	308	2.82	0.001	*
Control	152	44.57	4.34				

*significant at $\alpha = 0.05$ level

From Table 6, the t-test analysis revealed that since p = 0.001<0.05 level of significance, the null hypothesis (Ho_4) was rejected. Thus, there is a significant difference between the mean post-interest scores of students in experimental and control groups.

Hypothesis 5

Data for testing the research hypothesis 5 is presented in Table 7

HO_5.: There is no significant main effect of gender on senior secondary school students' interest in geometry.

Table 7: t-test comparison of the mean interest scores of students in the experimental and control group based on gender

Test	Gender	N	Mean	S.D	Df	t-value	p-value	Decision
Pre-GIS	Male	88	21.23	6.48				
	Female	70	22.81	7.02	156	3.22	0.002	*
PostGIS								
	Male	88	52.80	11.37				
	Female	70	41.17	9.42				

*Significant at $\alpha = 0.05$ level

From Table 7, the calculated p-value of 0.002 is less than 0.05 level of significance. Hence there is a significant difference in the mean interest scores of male and female students in favour of males. Thus hypothesis 5 which states that there is no significant main effect of gender on senior secondary school students' interest in geometry was rejected.

Discussion

This study has shown the efficacy of concept-mapping instructional strategy in facilitating secondary school students' achievement in geometry. The results from Table 1 show that the mean gain in experimental group is higher than that of control group. This is further confirmed by the result in Table 5 which reveals that method was a significant factor on students' achievement in the geometry content. Hence students

who were taught using the concept-mapping instructional strategy performed better than those who were taught using the conventional method. The result of this study extends the findings of Ali (2015), Ayiede (2010), Adaramola (2012) , Eze & Bot (2014) and Bot & Eze (2016) who asserts that students demonstrated greater understanding of mathematics as a result of exposure to the concept mapping technique.

Table 5 shows that there is no significant main effect of gender on senior secondary school students' achievement in geometry This means that male students did not achieve significantly better than their female counterpart in geometry content. This finding was consistent with the finding by Charles- Ogan (2014) who indicated in his study that there were equivalent numbers of male and female students with mathematics disability. This result also fall in line with the positions of Adaramola (2011), Gbodi & Laleye (2006) who debunked the idea of gender differentiation in ability. They rather posited that women, when given the chance could actually prove their mettle and compete favourably with men in mathematics

The results from Table 5 also shows that gender did not interact significantly with method to influence students' achievement. This result is consistent with the findings of Ezeugo and Agwagah (2000), Bot and Eze (2016) who reported that gender did not have any significant interaction effect on the achievement scores of students taught mathematics concepts using concept- mapping instructional strategy.

Since method by gender interaction was not significant, it follows that the difference in the mean achievement of male and female students was not due to method of instruction. Thus concept-mapping instructional strategy which has been found to enhance achievement in mathematics can be conveniently used by mathematics teachers in both male and female schools.

In comparing the mean post interest scores of the students in the experimental and control group of the students as shown in Table 3, it was observed that the mean post interest score in the experimental group was higher than that of the control group.

The results in table 6 shows that method of teaching however has significant effect on the groups. This shows that there is significant main effect of treatment on senior secondary school students' interest in geometry. The result is consistent with the reports of Yildrin and Adyin (2005), Odogwu (2002) , Yunus (2010), Abakpa and Iqwue (2013) who stated in their studies that effective teaching methods improve the students interest towards a subject.

Results of Table7 also show that there is significant main effect of gender on senior secondary school students' interest in geometry. This result also tally with the study of Alio (2000) who stated that effective teaching technique is a significant factor for student's interest when gender is taken into consideration. The significant difference between using concept maps and gender can be interpreted in light of the cognitive style theory that categorizes males and females into different learning styles. According to Suonma and May (2008), males are field-independent learners while females are field-dependent learners. Field independent individuals, such as males, use active reasoning patterns that include cognitive structuring skills, while field dependent individuals, such as females, accept reality and may become passive learners.

Conclusion

Based on the findings of this study, the following conclusions were made. The use of concept-mapping instructional strategy in teaching geometry has proved a more effective approach in teaching mathematics. The method employs independent thinking in the students and impacts more of conceptual understanding than the usual rote learning that most of the students engage themselves in.

This approach has proved itself capable of reconciling gender differences in students' achievement in mathematics. This notion of mathematics as a "masculine subject", has been shifted by this approach since method by gender interaction was not significant,. Thus concept-mapping instructional strategy which has been found to enhance achievement in mathematics can be conveniently used by mathematics teachers in both male and female schools.

This study has implications especially for mathematics teachers in Nigeria where mathematics curriculum is being restructured and redeveloped with much emphasis on concept attainment. Adopting concept- mapping instructional strategy in mathematics classes will aid students to develop better understanding of important concepts. This was demonstrated in this study as students were able to figure out relationships between concepts, create meaningful schemes and construct knowledge bases. In this way, students would be much better prepared to face future mathematics courses.

Recommendations

On the basis of findings of this study and the discussions, it is recommended that:

1. Students should be taught how to construct concept maps on their own on various topics in mathematics because this improves the cognitive structures of the students.
2. Since the study revealed that the use of concept-mapping instructional strategy enhances students' interest and achievement in mathematics, mathematics teacher should incorporate these techniques in mathematics classroom.
3. Textbook being a primary tool to deliver the concept to the students lays a heavy responsibility on the textbook writers to develop a balanced textbook in terms of content, methodology, practical activities and assessment exercises. The textbook writers are urged to include concept maps and concept- mapping activities in the textbooks.
4. Regular workshops, seminars and symposia on the use of instructional models in general and concept-mapping in particular should be organized by the Ministry of education and other stakeholders for secondary school mathematics teachers in order to enhance their methodological skills.

References

Abakpa, B.O. &Igwue, D.O. (2013). Effects of mastery learning Approach on senior secondary school students' achievement and interest in geometry in Makurdi, Benue state, Nigeria. ABACUS: *Journal of Mathematical Association of Nigeria 34(1), 102- 116.*

Adaramola, M. O. (2011). Bridging the gender gap in Mathematics performance through Mathematical games: Implication for basic Education in Nigeria. Sadiku,J.S (ed),*Proceeding of the Annual National Conference of Mathematical Association of Nigeria,* 64-70.

Adaramola , M. O. (2012). Effects of concept- mapping on performance in secondary school mathematics in Nigeria. *ABACUS: Journal of Mathematics Association of Nigeria*, 37(1), 195-207.

Adewumi, A.O.(2012). Factors influencing effective learning of mathematics at senior secondary school level in education District IV in Lagos state. ABACUS *Journal of Mathematical Association of Nigeria*). 37(1), 49- 56.

. Ajaja, O. P. (2011). Concept -mapping as a study skill: Effects on students achievement in Biology. *International Journal of Education Science,*3(1), 49-57.

Ali. A. (2015). Effects of concept-mapping and inquiry strategies on achievement and creativity among Colleges of Education Physics students in North- East Nigeria. *Unpublished Master's Degree Thesis, Ahmadu Bello University, Za*ria.

.Alio, B,C. (2000). The effect of Polya's language technique in teaching problem solving in Mathematics on secondary school students' interest. Proceedings of Annual National Conference of Mathematical Association of Nigeria. 15-39.

Alio, B. C. & Harbor-Peters, V. F. (2000). The effect of Polya's problem-solving technique on secondary school students' achievement in mathematics. *ABACUS, Journal of Mathematical Association of Nigeria,* 25(1), 26-38.

Ayiede, S.A. (2010). Concept- mapping instructional strategy and its effects on students' learning achievement. *Nigerian Journal of Professional Teachers*, 1(6), 1 -12.

Bot, T.D & Eze, J.E. (2016). Comparative effects of concept -mapping and cooperative learning strategies on secondary school students' achievement in Mathematics-trigonometry in Kano state, Nigeria. *European Journal of science and Mathematics Education*. *4(1),* 56- 66.

Canas, A.J. & Novak, J.D. (2006). The theory underlying Concept maps and how to Construct and use them. *Institute for Human and Machine Cognition*.

Charles-Ogan, G. (2014). Metagognitve strategy and senior secondary school Mathematics students' misconceptions in Rivers state. *Journal of Mathematical Association of Nigeria (JMAN).*39(1), 234 – 246.

Eguavon, O. (2002). *Mathematics: The heartbeat of information Technology-Implication for Secondary Education*. J.S.,Sadiku (ed), Proceedings of Annual Conference of Mathematical Association of Nigeria. 56 - 64.

Eniayeju,A.A.(2010). Effects of Cooperative learning strategy on the Achievement of Primary six pupils in Mathematics. ABACUS *Journal of Mathematical Association of Nigeria (JMAN),* 35(1), 1-9.

Etukudo, U. E. (2002). The effect of computer–assisted instruction on gender and performance of Junior Secondary school students in Mathematics. *Abacus. Journal of Mathematical Association of Nigeria (MAN),* 27(1), 1-8.

Eze, J. E. & Bot, T.D. (2014). Effect of concept mapping on secondary school students' achievement in mathematics in Bichi Education Zone, Kano state. *African Journal of Arts, Science and Educational Issues*. 2(2), 45-56.

Ezeugo, N. C., & Agwagah, U. N. V. (2000). Effects of concept- mapping on students' achievement in algebra; implications for secondary Mathematics education in the 21st century. *ABACUs, Journal of Mathematical Association of Nigeria (JMAN), 25(1*), 1-12.

Federal Government of Nigeria (2013). *National Policy on Education. Lagos*: NERDC Press. *P9.*

Gbodi, B.E. & Laleye, A. M. (2006). Effects of videotaped instruction on learning of integrated Science. *Journal of Research in Curriculum and Teaching.*1 (1), 10-19

Ibrahim, M.O. & Busari, I.O. (2016). The impact of enriched lecture method with Geotrigonometric set on Academic performance of Secondary school Students in Trigonometric concepts in Katsina State, Nigeria. *Proceedings of the annual national Conference of mathematical association of Nigeria*, 16-23.

Jahun I. U., & Momoh, J. S. (2001). The effects of Sex and environment on the mathematics achievement of JSS III students in Kwara State. *ABACUS, Journal of Mathematical Association of Nigeria,* 26(1), 53-58.

Kacar, A. & Tuna, A. (2013). The effect of 5E learning Cycle model in teaching Trigonometry on Students' academic achievement and the performance of their knowledge .*International Journal of New trends in Education and their implication*. *4(1),* 73-82.

Odogwu, H.N. (2002). The mathematics teacher factor in achievement of the goals of Universal Basic education. *ABACUS*; *Journal of Mathematical Association of Nigeria.* 27(1&2), 72-79.

Onyishi, E.U. & Agwagah, U.N.V. (2011). Improving the Teaching and the learning of Mathematics through the use of mind map for the attainment of Millennium development Goal. *ABACUS, The Journal of Mathematical association of Nigeria*, 36(1), 27-34.

Suonma, B. & May, A. (2008). The effects of using concept maps as study tools on achievement in chemistry. *Eurasia Journal of Mathematics, Science and Technology Education*. *4(3*), 233- 246

West African Examination Council, (2015). *Mathematics Chief Examiner's Reports. Lagos*

Yildrian, G. & Aydin, E. (2005). The effects of mastery learning and cooperative, competitive and individualistic learning environment organization on achievement and attitude in Mathematics. *Journal of the Korean of mathematics Education series*. 9(1), 55-72

Yunus, K, (2010) The effect of concept mapping on attitude and achievement in a physics course. *International Journal of the Physical Sciences*. 5(6), 724-737,*Available online at http://www.academicjournals.org/IJPS*.

Zakaria, E. & Iksan, Z. (2007). Promoting Cooperative learning in Science and Mathematics Education: A Malaysian perspective. *Eurasian Journal of Mathematics, Science and Technology*, 3(1), 35-39.