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Effect of computer based concept mapping on senior secondary school students' achievement in mathematics in rivers state

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Abstract
This study investigated the effects of Computer Based Concept Mapping (CBCM) instructional strategy on students' achievement in Mathematics. The achievement of students taught with CBCM was compared with those students taught with problem based learning method (PBLM). In carrying out the study, three research questions were raised and two hypotheses were formulated and tested at 0.05 significant level. Mean and standard deviation were used to answer the research questions. Hypotheses were tested using Analysis of Covariance (ANCOVA). Related literatures were reviewed. The design of the study was a quasi-experimental pre-test post-test control design involving three groups. The population of the study included 1820 SS 11 students in Ahoada East local government area while the sample of the study consisted of 121 Senior Secondary Two (SSII) Mathematics students from two State Government owned Secondary Schools. This was drawn using purposive and simple random sampling techniques from 15 Government Schools and one Federal Government College in Ahoada East Local Government Area of Rivers State. The two schools were assigned to experimental CBCM and one control (PBLM) groups. One instrument, Mathematics Achievement Test (MAT) was developed and validated. An internal consistency of MAT was computed and found to be 0.91 using Kuder – Richardson formula 20 (KR 20). The result of the analysis indicated that CBCM had significant effects on students' academic achievement in Mathematics. Gender was a significant factor in students' academic achievement in Mathematics when treated with CBCM. These findings imply that there is the need for mathematics teachers to adopt the use of CBCM in teaching since it is effective in improving students' achievement in Mathematics. Thus, it is recommended among others, that since the use of CBCM in teaching has been found to enhance the quality of achievement in Mathematics, Mathematics teachers should adopt the use of concept mapping technique as a purposeful strategy in effectively teaching Mathematics.

Keywords: computer based, concept mapping, effect & students' achievement

Introduction

Mathematics is a very important subject. It is the language of Science and Technology; so, it is a force to reckon with in the development of any nation. Every individual needs mathematical knowledge to function intelligently and efficiently in the world. Mathematics is one subject that is an integral part of everyone's life and affects virtually every field of human endeavour. An average man needs Mathematics to survive no matter how rudimentary. Ale and Adetula (2010) [2] stated that the line of demarcation between the developed and the underdeveloped nations is based on their level of mathematical attainment and ingenuity. Mathematics is more than a simple subject; it is a language that helps to describe ideas and relationships drawn from our environment. Mathematics is a tool of Science and Technology that enables people to explore concepts with idealized models before trying the concepts in the real world (Clark and Fulton, 2003) [3]. Mathematics as a subject can be seen in all facets of life and in day-to-day occupations such as internet technology, banking, construction, medicine, scientific discoveries and even in our planning of daily activities and many others. Mathematics remains a core subject in both the primary and secondary schools (Federal Republic of Nigeria, 2014).

The use of technology when studying Mathematics is not a new issue, since humankind always has been looking for solutions to avoid time consuming routine work. The use of technology has a long history in Mathematics education starting from magic slate, book, magic lantern, blackboard, radio, Slide rule video tape, Television; Clinometers are useful for teaching and learning of Trigonometry. An abacus allows children to conceptualize Mathematics formulas by working with tangible objects. Concept maps are graphical tools used for organizing and representing knowledge (Mutodi & Chigonga 2016) [7].

Concept mapping presents the hierarchical structure of students' ideas with an emphasis on the relations between concepts and their manifestations; previous theoretical studies have recognized that concept mapping can provide the necessary framework for students to interpret and organize their knowledge. Concept mapping is helpful for students to integrate new knowledge and build on their existing naïve concepts. Computer based concept mapping is an instructional strategy that incorporates the use of computer instruction with concept mapping.

However, failure to meet the standards of proficiency is a complex matter to pin point the blame even to the learners. There are many variables like teacher quality, financial resources of the school, quality of instruction, and many more

are out of the learner's control. Many empirical research on the influence of gender on students' achievement are conflicting and inconclusive; most of the literature reviewed showed that male students perform relatively better than their female counterpart in Mathematics Nwosu (2001) [8] stated that girls are denied out of school and pre-school experiences especially those involving visual activities-behaviour. This is a problem as it inhibits the development of Mathematics and science capabilities in girls. This study therefore, examined Computer Based Concept Mapping Instruction on students' academic achievement in Mathematics.

Statement of the Problem

The problem of this study is the poor academic achievement of students in senior school certificate examination in Mathematics (WAEC, 2011, 2012, 2013, 2014, 2015, 2016 in Zalmon and Wonu 2017). This situation calls for an alternative teaching technique that will guarantee effective and meaningful learning. According to Abakpa and Igwu (2013) [1], different studies have shown that an effective teaching approach increases students' academic achievement in a learning task. In a situation where students will be blamed for poor achievement, emphasis is only placed on the students' cognitive or intellectual ability, little or no attention given to the teaching style which may also be a problem as to why their achievement is poor. Based on the above assertion the study tends to find out the effects of computer based concept mapping on students' academic achievement in Mathematics.

Aim and objectives of the study

The aim of this study is to ascertain the effect of computer based concept mapping on senior secondary school students' academic achievement in Mathematics.

The specific objectives of the study were to;

1. Investigate the extent to which computer based concept mapping on secondary school 11 (SS2) students' academic mean achievement score in Mathematics as compared with those taught with problem based learning method.
2. Compare the mean achievement scores of male and female senior secondary school two (SS2) students'in Mathematics.
3. Establish the interaction effect of gender and treatment on the academic achievement of students in Mathematics as measured by their academic mean achievement scores in Mathematics. Achievement Test (MAT).

Research Questions

The following research questions guided the study:

1. To what extent does computer based concept mapping instructional strategy affect secondary school (SS2) students' academic mean achievement score in Mathematics compared with those taught with problem based learning method?
2. What is the effect of gender on secondary school (SS2) students' mean achievement score in Mathematics using computer based concept mapping instructional strategy?
3. What is the interaction effect of gender and treatment on the academic achievement of students in Mathematics as measured by their mean achievement scores in Mathematics Achievement Test (MAT)?

Hypotheses

The following formulated hypotheses were tested at 0.05 level of significance:

HO_1: There is no significant difference between the mean achievement scores of students taught Mathematics using computer based concept mapping and problem based learning method

HO_2: Gender does not significantly affect the mean achievement scores of students taught Mathematics using computer based concept mapping and those taught using problem based learning method.

HO_3: There is no significant interaction effect of gender and treatment on the academic achievement of students in Mathematics as measured by their mean achievement scores in Mathematics Achievement Test (MAT).

Methodology

The research design that was adopted for this study is a Quasi-experimental design. This design represents one level of treatment (computer based concept mapping and problem based learning method for the control group) and gender (male and female)**.** The population of this study consisted of all senior secondary two (SSII) Mathematics students in the Secondary Schools in Ahoada East Local Area of Rivers State. The target population is one thousand eight hundred and twenty (1,820) senior secondary school Mathematics students in SSII. This population comprises nine hundred and sixty two (962) males and eight hundred and fifty eight (858) females. The researcher used simple random sampling technique to get the sample for this study. Therefore, the total number that was sampled for this study from the sampled schools was 121 students consisting of 56 females and 65 males.

Research Instrument

The instrument that was used in collecting data in this study was Mathematics. Achievement Test (MAT) adapted from past examination questions of West African Examination Council (WAEC) and National Examination Council (NECO). The Mathematics Achievement Test (MAT) consisted of 50 objective items, based on SSII curriculum on the concept of trigonometry. Each item of the instrument was a multiple choice question with four options (A-D). The students were made to respond to the instrument in two sections. The first part (section A) elicited information on the students' personal data, while section B elicited information on the achievement of the students in the contents. This was administered to the experimental and control groups as pretest and posttest. To reduce the effect of pretest on posttest, the questions were reshuffled and administered in a different random order in the posttest. On the scoring of the multiple choice items, two (2) marks were awarded for each correct. Hence, the instrument was scored over 100 (2 x 50 items).

Validation of the Instrument.

Face and content validity of the instrument Mathematics Achievement Test (MAT) was carried out by four experts in the department of Curriculum Studies and Educational

Technology, University of Port Harcourt. They determined the appropriateness of the instrument, clarity and simplicity of the test items as well as its suitability for the level of the students, the extent to which the items cover the topics they are meant to cover, possible errors in suggested answers and the structuring of the items. The test items were corrected or modified on the basis of suggestions and recommendations of the experts.

Reliability of the Instrument

A pilot test was conducted in the study to ascertain the reliability and suitability of the Mathematics achievement test instrument. The pilot test was carried out using thirty (30) students who were randomly sampled from Federal Science and Technical College and Government Secondary Schools Ahoada. Though this sample is in the population of this study it is not among the sample for this study. The Mathematics Achievement Test (MAT) was administered once. The result of the test was analyzed using the Kuder-Richardson formula (K-R 20). The reliability coefficient (r) of the Mathematics Achievement Test (MAT) was found to be 0.91.

Research Question 1: what is the effect of computer based concept-mapping instructional strategy on secondary school students' mean achievement score in Mathematics over those taught with problem based learning method?

Table 1: Mean Pretest, Posttest and Learning gain of students taught using PBLM and those taught using CBCM respectively

Strategy	N	Pre-test		Post-test		Mean Gain	SD
		Mean	SD	Mean	SD		
CBCM	60	51.63	10.37	72.35	8.45	20.72	5.99
PBLM	61	34.66	12.06	37.41	11.62	2.75	3.21

Table 1, it can be observed that there was a significant difference in the achievement of students taught Mathematics using computer based concept mapping (CBCM) and problem based learning method (PBLM). This is because the Pretest mean score and standard deviation of the students taught using CBCM was 51.63±10.37 whereas that of their counterparts taught using PBLM was 34.66±12.06. The Posttest mean score and standard deviation of students taught using CBCM were 72.35±8.45 whereas that of those taught using PBLM was 37.41±11.62. The mean learning gain score and standard deviation of students taught using CBCM was 20.72±5.99 while that of their counterparts taught using PBLM was 2.75±3.21 which is in favour of the CBCM group. This signifies that the CBCM group benefited more in the lesson. Hence the CBCM teaching strategy has affected students' achievement in Mathematics.

Research question 2: What is the effect of gender on secondary school (SS2) students' mean achievement score in Mathematics using computer based concept-mapping?

Table 2: Mean Pretest, Posttest and Learning gain of the male and the female students taught using CBCM

Gender	N	Pre-test		Post-test		Mean Gain	SD
		Mean	SD	Mean	SD		
Male	31	50.45	10.62	72.81	8.85	22.35	5.98
Female	29	52.90	10.12	71.86	8.14	18.97	5.57

Table 2 shows that Pretest mean score of the male students taught using CBCM were almost at the same level of achievement with a mean achievement score and standard deviation of 50.45±10.62.Whereas that of their female counterparts taught using the same strategy was 52.90±10.12. The Posttest mean score and standard deviation of the male students taught using CBCM were 72.81±8.14, whereas that of their female counterparts was 71.86±8.14. The difference in the post achievement mean scores of male and female is 0.95 in favour of the male. The mean learning gain and standard deviation of the male students taught using CBCM were 22.35±5.98 whereas that of their female counterparts was 18.97±5.57. This signifies that the male students benefited more in the lesson. Hence CBCM teaching technique has more effect on achievement of male students than female students.

Research question 3: what is the interaction effect of gender and treatment on the academic achievement of students in Mathematics as measured by their mean achievement score in Mathematics achievement test (MAT)?

Table 3: The interaction effect of gender and treatment on the academic achievement of students in Mathematics.

			Pretest		Posttest		Mean	
Treatment	Gender	N	Mean	SD	Mean	SD	Gain	SD
CBCM	Male	31	50.45	10.62	72.81	8.85	22.35	5.98
	Female	29	52.90	10.12	71.86	8.14	18.97	5.57
PBLM	Male	34	32.82	10.16	34.94	9.71	2.12	3.81
	Female	27	36.96	13.96	40.52	13.19	3.56	2.03

Table 3 Shows that the mean learning gain score and standard deviation of male students taught using taught using CBCM were 22.35±5.98 while that of their female counterparts was 18.97±5.57. The mean learning gain scores of male students taught using PBLM was 2.12±3.81 whereas that of their counterparts was 3.56±2.03. This signifies that students benefited more in CBCM lessons than in RVI and PBLM lessons. Hence CBCM has more effect on academic achievement on students.

H_{01}: There is no significant difference between the mean achievement scores of students taught Mathematics using computer based concept mapping and problem based learning method

Table 4: Summary of ANCOVA on the difference between the mean achievement scores of students taught Mathematics using CBCM and those taught using PBLM respectively

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	47018.246[a]	2	23509.123	1242.147	.000
Intercept	2909.486	1	2909.486	153.728	.000
Pre MAT	10091.113	1	10091.113	533.182	.000
Treatment	8490.739	1	8490.739	448.624	.000
Error	2233.291	118	18.926		
Total	411765.000	121			
Corrected Total	49251.537	120			

Table 4 shows that there is significant difference between the mean achievement scores of students taught Mathematics

using computer based concept mapping(CBCM) and problem based learning strategy (F1, 118=448.624, p<.05). The null hypothesis that there is no significant difference between the mean achievement scores of students taught Mathematics using computer based concept mapping and problem based learning method was rejected at 0.05 alpha level and the alternate accepted.

H_{02}: There is no significant difference in the mean achievement scores of male and female students taught Mathematics using computer based concept mapping and those taught using problem based learning method.

Table 5: Summary of ANCOVA on the difference in the mean achievement scores of male and female students taught Mathematics using CBCM and those taught using PBLM

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	38580.926[a]	2	19290.463	213.322	.000
Intercept	1.993	1	1.993	.022	.882
Pre MAT	38157.889	1	38157.889	421.966	.000
Sex	53.419	1	53.419	.591	.444
Error	10670.611	118	90.429		
Total	411765.000	121			
Corrected Total	49251.537	120			

H_{03}: There is no significant interaction effect on gender and treatment on the academic achievement of students in Mathematics as measured by their mean achievement score in Mathematics. Thus the null hypothesis was retained.

Table 6: Summary of ANCOVA on the interaction effect on gender and treatment on the academic achievement of students in Mathematics.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	57354.820[a]	6	9559.137	439.914	.000
Intercept	6542.367	1	6542.367	301.081	.000
PreMAT	13019.615	1	13019.615	599.166	.000
Treatment	14046.704	2	7023.352	323.217	.000
Sex	42.023	1	42.023	1.934	.166
Treatment * Sex	242.109	2	121.055	5.571	.005
Error	3846.132	177	21.730		
Total	680525.000	184			
Corrected Totals	61200.951	183			

Table 6 shows that there is significant interaction effect on gender and treatment on the academic achievement of students in Mathematics (F2, 177=5.571, p<.05). The null hypothesis three was rejected at 0.05 alpha level.

Discussion of the Results

Based on the analyses carried out in this study, the result revealed that students taught using CBCM had a mean gain of 20.72 against 2.75 for student taught Mathematics using problem based learning method in secondary schools in Rivers state. There was a significant relationship between the interaction effect of gender and treatment on the achievement of students in Mathematics. The result also revealed that male students benefited more when taught Mathematics concept using CBCM. This finding is in agreement with the findings of Lou, Wen and Tseng (2007) whose research findings revealed a no significant difference in the academic achievement between genders in the experimental group that were treated with computer assisted concept mapping. This result is in agreement with the result of Tan and Seng (2000) who found out that computer based concept mapping enhanced students achievement in Mathematics. Tenth grade students in Singapore were treated with computer based concept mapping and the students in these group performed significantly better than those without computer based concept mapping. Therefore it can be concluded that CBCM when used in teaching the concept of trigonometry will improve students' achievement in Mathematics.

Conclusion

Based on the findings of this study, the following conclusions were drawn:

The study had shown that CBCM had significant effects on the students' academic achievement in Mathematics. The influence of gender on academic achievement in Mathematics was significant. Male students were found to be superior to their female counterpart when CBCM was used.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. Since the use of CBCM in teaching has been found to enhance the quality of achievement in Mathematics, Mathematics teachers should adopt the use of concept mapping technique as a purposeful strategy in effectively teaching Mathematics. By so doing, the achievement of students in the subject could be increased.
2. Enlightenment campaign, workshops and seminars should be organized for teachers by Education Authorities, Federal and State Ministries of Education, institutes and Colleges of Education to create awareness of the efficacy of the strategies/methods and then sensitize the adoption of the methods/strategies in their various schools.
3. Mathematics textbooks and learning resources are very important and a necessary components in Mathematics classrooms. They are essential for both students and teachers, as a possible regulator of what teachers know and are able to present to students, good quality textbooks with correct description of concepts should be made available to both teachers and students to reduce abstractness and misconception of the subject.

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