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Full Length Research

Effects of Collaborative Concept Mapping Teaching Approach on Students' Academic Achievement in Mathematics in Junior Secondary Schools in Batagarawa Local Government Area of Katsina State

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Abstract

This study set out to examine the effect of collaborative concept mapping teaching approach on students' academic achievement in mathematics in junior secondary schools. The research adopted quasi-experimental non-randomized pre-test, post-test, control group design. Data was collected from a sample of students comprising 84 boys and 61 girls from two randomly selected public junior secondary schools in the Batagarawa Local Government Area of Katsina state. Collaborative concept mapping teaching approach was used for the experimental classes while the control classes were taught using the conventional method. A 40 item instrument called Mathematics Achievement Test (MAT) developed by the researcher with a reliability coefficient of 0.88 using Kuder-Richardson formula 21 was used for data collection. Data collected were analyzed using descriptive statistics of mean and standard deviation for answering the research questions and t-test at coefficient alpha level of 0.05 for testing the hypotheses. The results showed that there was significant difference between the achievement of students taught with collaborative concept mapping teaching approach and their counterpart in the control group. Collaborative concept mapping teaching approach was found to be gender friendly as both male and female students performed equally. Based on these findings, it was recommended that mathematics teachers should be encouraged to incorporate collaborative concept mapping teaching approach to their teaching methods. Seminars, workshops and conferences should be organized to train teachers on the use of the reality pedagogy approach.

KEY WORDS: Collaborative Concept Mapping, Concept Mapping, Mathematics, Achievement and Conventional method

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INTRODUCTION

The need for students' better achievement in mathematics has driven teachers and researchers to seek appropriate instructional strategies that can help to impart mathematics knowledge to students meaningfully. These instructional strategies are the ones that would allow students to control their learning process as well as develop the required performance in mathematics. According to Jegede, Alaiymola and Okebukola (2009), the increasing awareness of the importance of learner centeredness in the teaching-learning situation has generated a lot of attention in relation to understanding how learners learn and how to help them learn about concepts.

Efforts in assisting learners to learn more effectively has led to the development of meta-cognitive strategies to enhance meaning full learning (Cliburn; 2009). According to Novak (1987) meta-cognitive strategies are strategies that empower the learner to take charge of his/her own learning in a highly meaningful fashion. Borich (2004) noted that meta-cognition which is a strategy used in self-directed learning are mental processes that assist learners to reflect on their thinking by internalizing, understanding, and recalling the content to be learned. Such strategies include schema activation, cognitive mapping, consequence mapping, vee mapping, concept mapping, collaborative concept mapping Graphic organizers; Constructivism based learning and so on.

A concept mapping is a diagram showing the relationship among concepts. They are graphical tools for organizing and representing knowledge. Ton (2007) describes concept mapping as a way of representing relationship between ideas, images, or words in the same way that a sentence diagram is made. Brikerhoff and Booth (2013) describe concept mapping as a schematic device for representing the relationships among a set of concepts. A concept is a perceived regularity in events or objects, or records of events or objects, designated by a label. Concept mapping is a technique for externalizing one understands of a conceptual framework. When concept mapping is not focused on individual concepts, but on the organization of a set of concepts in a conceptual framework it is called collaborative concept mapping. Collaborative Concept Mapping Teaching Approach (CCMTA) is a hybrid teaching/learning strategy involving an interaction between two or more individuals during concept mapping to create a shared understanding of a concept, discipline or area of practice that none had previously possessed or could have come to on their own (Johnson, Johnson & Smith, 1991 cited by Kipkemoi, 2019). Kipkemoi (2019) sees collaborative concept mapping as a great tool to use during a learning session for students to check their understanding together and build on what they already know. Collaborative Concept Mapping Teaching Strategy (CCMTS) is likely to be an effective summative

assessment technique that enhances rich discussion amongst students who have already individually engaged with the concept mapping activity. Collaborative concept mapping benefits from the interactions with others by allowing learners to blend their thoughts and experiences while trying to achieve understanding of subject content.

Concept mapping has been claimed to be valid in assessing students' conceptual changes. For example in Wallace and Mintzes(1990) study, concept mapping was used as both a pre-test and a post-test, and the capability of concept mapping to identify students' conceptual change due to the treatment effect (concurrent validity)was studied. They found out that students' in concept maps were substantially different in complexity and propositional structure of the knowledge base from the pre-test to the posttest and concluded that concept mapping is a valid tool to document students' conceptual change. Fred (2009) examined effects of Concept and Vee Mapping Strategy (CVMS) on students' achievement and motivation in Biology. The results show that students taught using the CVMS had higher motivation and achievement than students taught using the traditional methods. The results also indicated that students' gender did affect achievement in Biology where girls performed better than boys. Ogbonna (2014) investigated effect of concept mapping on students' achievement and interest in selected concepts from organic chemistry. The finding revealed that: Concept mapping methods have statistically significant effect on students Achievement in Organic Chemistry and as well as significant effect on Students' interest in Organic Chemistry. Bright, Alex and Peter (2015) examined the effect of concept mapping approach on students' achievement in Mathematics in Secondary Schools. The result of the study showed that, concept mapping approach improved students achievement in mathematics, the method removed gender inequality. Based on the result of the study it was recommended that, concept mapping approach should be used by teachers in teaching mathematics in secondary schools to improve students' achievement. Kipkemoi (2019) examined effect of collaborative concept mapping teaching strategy on students' attitudes towards mathematics in secondary schools. The results revealed that there was statistically significant difference attitudes towards mathematics in favor of CCM between students exposed to Collaborative Concept Mapping teaching strategy and those taught using Conventional Method of Instruction. This study is designed to examine the effect of collaborative concept mapping teaching approach on students' academic achievement in mathematics in junior secondary schools in the Batagarawa Local Government Area of Katsina state.

Objective of the Study

The purpose of this study was to investigate the effects of

collaborative concept mapping teaching approach on students' academic achievement in mathematics in junior secondary schools in the Batagarawa Local Government Area of Katsina state. Specifically, the objectives of the study were to:

1. Find out if there is any difference in achievement of secondary school students taught mathematics with collaborative concept mapping teaching approach and those taught using conventional teaching method.
2. Find out if there is any difference in achievement of male and female secondary school students taught mathematics with collaborative concept mapping teaching approach.

Research Questions

The following research questions were answered in the study:

1. What is the difference between the mathematics mean achievement of secondary school students taught with collaborative concept mapping teaching approach and those taught using conventional teaching method?
2. What is the difference between the mathematics mean achievement of male and female secondary school students taught with collaborative concept mapping teaching approach?

Hypotheses

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

H₀₁: There is no significant difference between the mean of mathematics achievement of secondary school students taught with collaborative concept mapping teaching approach and those taught using conventional teaching method.

H₀₂: There is no significant difference between the mean of mathematics achievement of male and female secondary school students taught with collaborative concept mapping teaching approach.

Delimitation of the Study

This study explored the effectiveness of collaborative concept mapping teaching approach as an instructional strategy on students' academic achievement in mathematics in junior secondary schools in Batagarawa Local Government Area of Katsina state. The study was conducted in junior secondary schools that are located within the study area and restricted to two junior secondary schools in Batagarawa Local Government Area of Katsina state. The variables of the study

comprise of collaborative concept mapping teaching approach as independent variable while, academic achievement, and gender are dependent and intervening variables respectively. The study was limited to co-educational schools that have JSII class as at the time of this study. The reason for choosing this level of students was that it is a more stable class and they are not yet very close to writing their external examination.

Significance of the Study

The findings of this study would be of significance to the following curriculum planners, teachers, parents and students

Curriculum planners: The findings would be useful to curriculum planners who would wish to resolve the issue of teaching methods which affects students' performance may have cause to know the true situation and properly restructure mathematics curriculum to take care of the inadequacies discovered from the study. Curriculum planners would be more objective when the findings are taken into consideration.

Teachers: If teachers implement the curriculum properly with the adoption of appropriate teaching method, the objectives of the subjects would be achieved. The teachers would be in a better position to help students acquire a sound knowledge and reduce the difficulties in conceptualizing mathematics concepts and ideas. The findings of this study would also help mathematics teachers to be more effective in their lesson delivery to their students. It would enable them to know the effects of concept mapping in teaching and learning process in enhancing students' achievement in mathematics.

Parents: Parents are not exempted because they are concern about their children's achievement in mathematics in school. They are mindful of what their children actually learn in school. The findings may therefore equip their children toward the attainment of their goals in learning mathematics.

Students: The findings could help students translate the acquired knowledge to real life situation and also develop self confidence and self-esteem which will improve their academic performance toward mathematics.

Research Design

The design adopted for this study was quasi experimental design. Specifically, the researcher applied non randomized pre-test, post-test quasi –experimental design. This is because intact classes were used to avoid disruption of normal school lessons. The pre-test was used to establish the equivalence of the two (2) groups' i.e experimental and control groups while the post test was to determine the effects of collaborative concept mapping teaching approach on students' achievement in mathematics.

Table 1. The symbolic representation of Research design

Grouping	Pre-test	Treatment	Post-test
Experimental	01	X_1	02
Control	03		04

Where 01, 03 represent the pretest for the two groups

02, 04 represent the posttest for the two groups

X_1 represents treatment (experimental group)

No treatment (control group)

Population of the Study

The population for this study comprised all the Junior Secondary School (JSS) students in Batagarawa Local Government Area of Katsina state. The target population of the study consisted of all JSII students in Public Junior secondary schools in Batagarawa Local Government Area of Katsina state numbering 22, 5139. (Batagarawa Local Education Authority)

Sample Size and Sampling Procedure

A sample size of one hundred and forty five (145) students from two (2) junior secondary schools was selected for the study from Batagarawa Local Government Area of Katsina state. Simple random sampling technique was used to select two public schools for this study. The schools sampled for the study are: Government Girl's Secondary School Ajiwa and Government Rural Boarding Secondary School Batagarawa. Simple balloting was used to assign experimental and control to the selected schools. Table 2 shows the name of school and nature of treatment assigned.

Table 2. Sample size of Selected Schools and Groups

S/N School	SEX		Total
	Male	Female	
1. Experimental	44	32	76
2. Control	40	29	69
TOTAL	84	61	145
Instrumentation			

The instruments used for data collection was Mathematics Achievement Test.

The Mathematics Achievement Test (MAT) was researcher-made instruments for the students, and it consisted of forty (40) items prepared based on JSII mathematics schemes of work for the term. Each of the 40 items was a multiple-choice objective question with four options (A, B, C and D). It consisted of two sections: Section A, meant for general information about the students and section B, the achievement test. Time allowed was one hour each. The MAT was administered twice, before (pre) and after (post) the experiment. Data collected from the first administration was used to ascertain the level of students' mathematics knowledge and their homogeneity before the treatment. The post-MAT was used to determine the extent of students' mathematics achievement after the experiment.

The content of MAT was based on the content of the JSII mathematics syllabus for eight weeks from the term in which this study was carried out. Consideration was given to the objectives of the contents taught as that served as guide in determining the number of topics for each of the units. The items of MAT were developed to cover questions which test all levels of the cognitive domain. The mark for each answer was five marks totaling 100 marks for twenty questions.

Validity and Reliability of the Instrument

The instrument was subjected to both face and content validity. The validation of these instruments MAT was done by two experts in the department of mathematics from Federal College of Education Katsina. The corrections made by these experts were used to review the MAT. After the validation, the MAT items were subjected to pilot testing to ascertain the reliability of the instruments. The researcher conducted a pilot test in Government Day Secondary School Babanruga in Batagarawa Local Government. The school was not part of the two (2) secondary schools sampled for the study. Kuder-Richardson (KR- 21) formula was used to ascertain the internal consistency or reliability of the MAT. The value of 'r' was found to be 0.88. The decision to use KR-21 for testing the reliability of MAT was borne out of the fact that the items were not of equal difficulty but of the same level and that one single test scores was used for the reliability.

Data Collection Procedure

The conduct of the study took place during the normal lesson periods with two researcher assistants one from each selected school and each taught one class from the school following the normal time table of the school. The instruments MAT was administered as pre-test to both experimental and control groups, after that the teachers of the experimental group were then allowed to teach the students using collaborative concept mapping teaching approach for the eight weeks of the term following the training guide and procedures described in the lesson plan provided by the researcher while the control group used the conventional method. This group (control group) used teacher's typical method, which is teacher centered. The teacher provided objectives and presented information and less concern about the feedback from the students. At the end of eight weeks, the post-test MAT was administered. The assessment was used to evaluate students' achievement in both groups. The scripts were marked and scored with the use of a prepared marking scheme.

Method of Data Analysis

The data collected from the study were analyzed using mean and standard deviation to answer research questions, while t-test statistics at 0.05 level of significance was used to test the null hypotheses. The analysis was computer based, with the use of data analysis (statistical computation) software.

Data Analysis and Results:

The answers to questions that sought to establish the possible differences in achievement among the various groups are hereby presented using frequencies, mean and standard deviation.

Research Question One: What is the difference between the mean mathematics achievement of secondary school students taught with collaborative concept mapping teaching approach and those taught using conventional teaching method?

Table 3. Descriptive Statistics Showing Experimental Group and Control Group Achievement in the Post test

Groups	N	\bar{X}	SD
Experimental	76	67.4	9.83
Control	69	52.3	9.75
Mean Difference		15.1	

Results in table 3 indicate that students in the experimental group had a mean score of 67.4 with a standard deviation of 9.83 while those in the control group had mean score of 52.3 with a standard deviation of 9.75. In other words the students in the experimental group had a higher mean score of 15.1 more than their counterparts in the control group. This difference is possible because students in experimental group show much love and committed to learning of mathematics than those in control group that is why students in experimental group performed better than the students in control group in MAT.

Research Question Two: What is the difference between the mathematics achievement of male and female secondary school students taught with collaborative concept mapping teaching approach?

Table 4. Descriptive Statistics Showing Male and Female Students' Mean Achievement Scores in Experimental Group

Groups	N	\bar{X}	SD
Gender			
Male	44	66.8	6.95
Female	32	63.5	7.13
Mean Difference		3.3	

Results in table 4 indicate that male students had a mean score of 66.8 with a standard deviation of 6.95 while the female students had a mean score of 63.5 with a standard deviation of 7.13. In other words, the male students had a higher mean score of 3.3 than their female counterparts. This difference is possible because male students in experimental group show more commitment to learning of mathematics than female students that is why male students performed better than female students in MAT.

Test of Hypotheses

In this study four hypotheses were formulated and tested as follows:

Hypothesis One: There is no significant difference between the mean of mathematics achievement of secondary school students taught with collaborative concept mapping teaching approach and those taught using conventional teaching method.

Table 5. Two-tailed t-Test Result In Respect of Mean Achievement Score between the Groups Exposed to Concept Mapping and the Conventional Strategy

Groups	Mean	SD	N	df	t _{value}	Std Error	Sig.@0.05	Decision
Experimental	67.4	9.83	76					
				143	6.95	2.304	0.000	Significant
Control	52.3	9.75	69					

Table 5 shows that there was a significant difference between the mean achievement scores of students exposed to collaborative concept mapping teaching approach and those in control group as $t=6.95$, $df=143$, $P<0.05$. This hypothesis was therefore rejected. It then means that students' achievement in mathematics differs significantly with collaborative concept mapping teaching approach

Hypothesis Two: There is no significant difference between the mean of mathematics achievement of male and female secondary school students taught with collaborative concept mapping teaching approach

Table 6. Two-tailed t-test Result In Respect of Mean Achievement Score Between the Male and Female Students Exposed to Mathematics with Collaborative Concept Mapping Teaching Approach

Groups	Mean	SD	N	df	t _{value}	Std Error	Sig.@0.05	Decision
Male	66.8	6.95	44					
				74	1.85	1.538	0.742	Not Significant
Female	63.5	7.13	32					

Table 6 shows that there was no significant difference between the mean achievement scores of male and female students exposed to collaborative concept mapping teaching approach as $t=1.85$, $df=76$, $P>0.05$. This hypothesis was therefore not rejected. In other words, male and female students did not differ significantly in their mean achievement score in mathematics as a result of exposure to collaborative concept mapping teaching approach.

Discussion of Findings

The main purpose of the study was to examine the effects of collaborative concept mapping teaching approach on students' achievement in mathematics. Two research questions and two hypotheses were raised. The data presented in table 1 provide answer to research question one; finding revealed that students in the experimental group had a higher mean score than their counterparts in the control group. The result of t-test as reported in table 5 shows that there was a significant difference between the mean achievement scores of students taught mathematics with collaborative concept mapping teaching approach and those in control group. The implication of this finding is that the collaborative concept mapping teaching approach is more effective than the conventional method. The finding confirms that of Fred (2009) that student taught using the concept and vee mapping had higher motivation and achievement than students taught using the traditional methods. Also,

Ogbonna (2014) confirmed that concept mapping methods have statistically significant effect on students' achievement in Organic Chemistry than conventional method. This is possible because concept mapping has been found to facilitate meaningful learning as well as mastering of concepts. Practicing concept mapping leads to a mode of understanding of the concept and the relationship that exist among them noting that the development and understanding of concepts is made easy in learning science subjects.

The data presented in table 4 provide answer to research question two; finding revealed that male students in experimental group had a higher mean score than their female counterparts. The result of t-test as reported in table 6 shows that there was no significant difference between the mean achievement scores of male and female students' mathematics with collaborative concept mapping teaching approach. These findings confirm the work of Bright, Alex and Peter (2015) which showed that concept mapping approach improved

students achievement in mathematics, the method removed gender inequality as both the students performed equally.

CONCLUSION

From the findings of the study, the following conclusions were made:

Concept mapping strategy was found to make students explore a wider variety of ideas needed to boost students' learning outcomes. It enhances understanding of content, creative and critical thinking, expression of ideas and information using visual form and making connection in mathematics. Furthermore, there was no significant difference in achievement of male and female in mathematics taught with the collaborative concept mapping teaching approach. Therefore, the sustenance of students' achievement in mathematics can be achieved by application of this strategy. Through this instructional strategy, students were able to perform better than those taught with conventional approach.

RECOMMENDATIONS

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

1. Since collaborative concept mapping teaching approach has been found to enhance the achievement of students in mathematics, teachers should be encouraged to incorporate the strategy into their methods of teachings.
2. School supervisors, ministry officials and textbook authors should emphasize on the use of collaborative concept mapping teaching approach mathematics in junior secondary schools.
3. Seminars, workshops and conferences should be organized to train teachers in human capacity building to popularize the application of collaborative concept mapping teaching approach, given the fact that this among the recent innovative strategy for teaching and learning in junior secondary schools in Nigeria.
4. Teachers should try to avoid conventional strategy in the teaching learning at this level, since the present study has proved it to be inhibitive to learning outcomes.

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