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Effect of Concept-Mapping Strategy on the Attitude of Senior Secondary School Students of Varied Ability Levels in Algebra in Kogi State, Nigeria

By

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**ABSTRACT**

*This study investigated the effect of concept-mapping strategy on the attitude of secondary school students of different ability levels towards algebra in Kogi State, Nigeria. A quasi-experimental-control design comprising pretest and posttest was used and sample consisted of two hundred and forty (240) SS II students from six intact classes in six schools selected by multistage cluster sampling procedure from all senior secondary schools with a total population of 19215 SS II students in Kogi state Nigeria. These subject were divided into three ability levels: low, medium and high. One (1) hypothesis was formulated to direct the study. Algebraic Attitude Questionnaire (AAQ) was used to collect data from the sampled schools. Data collected were analyzed using Friedman Test and post hoc testing using Dunn Bonferroni analysis at  $P \leq 0.05$  level of significance. The result indicated that there are significant differences in the attitude mean rank responses in algebra among low, medium and high ability level students exposed to concept-mapping strategy and those exposed to conventional lecture method such that: the difference in the attitude mean rank responses in algebra between subject in each of the three ability levels exposed to concept-mapping strategy before and after treatment is significant among others. Based on the research findings, it was concluded that: Concept-mapping strategy has significant effect in developing the high, medium and low ability level student's attitude positively towards algebra. It is therefore recommended among others that the use of concept-mapping strategy for teaching mathematics should be encouraged in Nigeria senior secondary schools to develop high, medium and low ability level students' attitude positively towards algebra.*

**Key Words:** Concept-Mapping-Strategy, Attitude, Algebra, Ability Levels

**INTRODUCTION**

The experience of low participation in mathematics among students at varying levels of learning is a source of serious concern to educationists, parents and the general public (Ma & Xu, 2004). Mathematics occupies a central place in the Nigerian educational system. The importance of mathematics to nation building has led the Federal Government of Nigeria to make mathematics a core subject to be offered by students at all levels of education in Nigeria as stipulated in the National Policy on Education (FRN, 2013). Despite this policy in place, there is declining students' perceptions and participation in mathematics in the Nigerian senior secondary school as evident in students' performance in external examination like WAEC and

NECO. Guzel (2008) opined that negative attitude towards a certain subject makes learning or future learning difficult, hence when students are positively inclined towards a subject they tend to do well in that subject. Therefore, developing students' attitude towards mathematics is very crucial.

Moreover, Simpson and Oliver (2009) identified factors of teachers' attitude, teaching methods and teachers' personality, attitude of parents and peers, nature and perception of the subject among components influencing attitude to school subject. This explains that teachers are very important determinants of enrolment, achievement and essentially attitude towards school subjects (Alebiosu & Bamiro, 2010). The teacher is a consultant, guide, mentor, inspirator and moderator (Krejster, 2012). His/ her use of innovative instructional strategy stands a higher chance of positively influencing the attitude of the learner to the subject.

Attitude is defined by Royster, Harris and Schoeps (2012) as emotional trends in response to affairs, persons, locations, event or ideas. Therefore, the phrases as 'I like mathematics' or 'I enjoy mathematics can be enumerated as attitude. It was pointed out that Negative attitude towards a certain subject makes learning or future - learning difficult, hence when students are positively inclined towards a subject they tend to do well in that subject. Developing students' attitude towards mathematics as noted by Simpson & Oliver is the most important purpose of mathematics education.

It is an acknowledged fact that the mathematics classroom in senior secondary schools in Nigeria has been associated with traditional patterns of teaching and learning, a teachers-centered approach with greater emphasis on lecture method and a situation in which learners are passive listeners that have remained unchanged leading to persistence memorization of mathematical facts devoid of meaningful learning (Okoli, 2008). In order to improve instructional methods carried out in the classroom and improvement of students' attitude to learning, there have always been searches for more potential ways of instruction. More importantly, it was noticed by Alebiosu (2009) that instructional strategy and teaching method are important determinants of attitude to science and mathematics. However, the National Policy on Education stipulated that education activities shall be learner centered for maximum self-development and self-fulfillment. The need to devise alternative effective instructional strategy that work in line with the desire of this policy and the view expressed by experts is the purpose of this study. One of the strategies that permit child centered learning which has evolved as a useful tool in leading students towards meaningful learning is concept mapping.

Concept-mapping relates with the meaningful learning theory whose advantage lies on the fact that learning new knowledge is dependent on what is already known. It upholds that new knowledge is gain when it can be largely related to a framework of existing knowledge rather than being processed and stored in isolation. By using concept mappings, the learning process becomes active rather than passive (Danmole & Adeoye, 2004). Concept-mappings are diagrammatic representations which show meaningful relationships between concepts in the form of propositions which are linked together by words or phrase. Concepts which are enclosed in a circles or any other shape are arranged hierarchically with the super ordinate concepts at the top of the mapping, and subordinate at the bottom which are less inclusive than higher ones. Links and cross links are used to connect different segments of the concepts hierarchy, which

indicate syntheses of related concepts, a new interpretation of old ideas, and some degree of creative thinking. However, this study intends to determine whether or not the used of concept-mapping strategy could improve students of different ability level attitude positively towards algebra as compare to lecture method which according to Okoli (2008) failed to do such. More so, ability level in relation to concept-mapping is another variable in this study that needs to be highlighted.

Ability level is the classification of students into categories based on their performance in a test or examination. The indices of categorization are students' scores obtained from the test or examination. Experts such as Ajewole and Okebukola in Lakpini (2005) and Talca (2007) has identified three types of ability levels in relation to teaching learning situation. These are low, medium and high ability levels. Low ability level learners as indicated by Ofonime (2007) are those whose academic potentials are judged below class average while their performance is described as poor and they need constant study, evaluation and help so as to reverse their condition. Also, medium ability level learners are those who can only record average academic performance not because they are not capable of doing better but partly because they cannot put in extra effort to attain better performance hence, contend themselves to classroom learning without trying to reach out to other information (Awe, 2007). However, high ability level learners as pointed out by Ofonime (2007) are those whose academic potentials are above class average and their performance described as good.

The mode of categorization of students into each of the ability level based on test scores varies from expert to expert. Lakpini (2005) in her categorization placed students with scores ranging from 0 – 39 in low ability level, 40 – 60 in medium ability level and 61 – 100 in high ability level using pretest scores as index of categorization. The index of categorization by Talca (2007) was the use of average means score of students' SS<sub>1</sub> and SS<sub>2</sub> examination results. Those with scores between 0 – 49 were placed as low ability level, those between 50 – 64 as medium ability level and 65 – 100 as high ability level. In this study, Talca ability level classification was adopted base on the fact that it corresponds with WAEC and NECO grading system. This research paper aimed at investigating the effectiveness of concept mapping strategy in improving the attitude of high, medium and low ability level secondary school students in algebra.

The researcher's experience as a teacher at primary, secondary and tertiary level of education revealed a low participation in mathematics among students at varying levels of learning. This calls for investigation into factors that impede students' attitude towards mathematics. Top on the list of factors identified by researchers to influencing attitude to school subject is teaching methods, teachers attitude, teachers personality and that teachers do not use to consider ability level in the teaching of mathematics assuming that students are all the same in their ability to learn.

It is an acknowledged fact that the mathematics classroom in senior secondary schools in Nigeria has been associated with traditional patterns of teaching and learning, a teachers-centered approach with greater emphasis on lecture method and a situation in which learners are passive listeners that have remained unchanged leading to persistence memorization of mathematical facts devoid of meaningful learning. This culminated into students' low participation in mathematics, showing negative attitude to the subject and consequently

manifesting in their poor mathematics performance in external examination like WAEC and NECO (Okoli, 2008). Moreover, student perceptions that they cannot understand mathematics and that it is a hard subject is linked to image students have of mathematics as an abstract collection of rules and processes. This is particularly in the case of algebra where resources found in standard texts frequently do not encourage teachers to enact appropriate pedagogy (Doerr, 2004).

However, in order to improve mathematics teaching carried out in the classroom and improvement of students' attitude to learning, there have always been searches for more potential ways of instruction. It was on this note that the study investigated into the effect of concept-mapping strategy on the attitude of senior secondary school students of varied ability level in algebra in Kogi State, Nigeria to determine whether it can develop their attitude positively towards the subject or not.

### **Objectives of the Study**

This study was design to assess the difference (if any) that exist between attitudinal change of low, medium and high ability level students exposed to concept mapping strategy and compared to those exposed to conventional lecture method in algebra among SS II secondary school students.

### **Research Questions**

In addressing the problem at hand, this research question was raised for answering:

1. What are the differences between the pretest and posttest attitude mean rank in algebra of low, medium and high ability level students exposed to concept mapping strategy and those exposed to lecture method?

### **Null Hypotheses**

From the research question, this hypothesis was formulated for testing at 0.05 level of significance:

**H<sub>0</sub>** : There are no significant differences between the pre and post attitude mean rank in algebra among low, medium and high ability level students exposed to concept mapping strategy and those exposed to conventional lecture method.

### **RESEARCH METHODOLOGY**

The study used quasi-experimental control group design involving pre-test and post-test. This is because random assignment of subjects to the experimental and control groups were not allowed for the study rather, intact classes were assigned to experimental and control groups. Secondary school classes exist as intact groups and school authorities do kick against any attempt to dismantle and reconstitute them for the purpose of research since this will disrupt school academic calendar.

The pretest was conducted for the Experimental and Control groups to show the equivalency of the subjects studied in terms of their attitude in algebra before the treatment and

the posttest conducted to determine the impact of the treatment on the attitude of the subjects in algebra in various ability levels after treatment.

The target population of this study consisted of all the Senior Secondary two (SSII) students totaling 19,215 from 278 established public schools across the three senatorial districts of Kogi State, Nigeria for 2016/2017 academic session.

The multistage cluster sampling procedure was used in selecting the sample for the study. This involved six intact arm of classes from six schools in six local LGAs randomly selected from 21 Local Government Areas (LGAs) in the state. From the average scores of students in their SSII first and second term mathematics examination, using Talca (2007) categorization of students into ability level, students with scores from 0 to 49 in each of the six arms of classes were placed as low ability level, those with scores from 50 to 64 as medium ability level and those with scores from 65 – 100 as high ability level.

The six selected intact arms of classes were assigned randomly into experimental and control groups. The three arms that made up the experimental sample (N=133) consist of 28 high ability level students, 42 medium ability level students and 63 low ability level students. The three arms that made up the control sample (N=107) consist of 24 high ability level students, 33 medium ability level students and 50 low ability level students. This give a total sample size (N=240) which is viable for this study in line with Tuckman (1975) and Sambo (2008) who recommended that sample size of minimum of 30 subjects is viable for experimental study of this nature.

Data collection was through the use of a 40-item questionnaire tagged Algebraic Attitude Questionnaire (AAQ) to determine whether if employing the concept-mapping strategy can bring about students' favourable positive predisposition towards algebra or otherwise. It was an adaption for algebra from the work of Yunusa (2010) on attitude towards physics. AAQ includes items that were scored using a 4-point Likert type scale, ranging from Strongly Agree, Agree, Disagree, and Strongly Disagree and this was administered before and after treatment. In the scoring procedure, a choice of strongly agree was scored as 4 points, agree 3 points, disagree 2 points and strongly disagree as 1 point.

The content of AAQ were assessed and corrected by two mathematics educators (Lecturers) who are professors in mathematics education from science education department and a specialist in English Language from English department, all from Ahmadu Bello University Zaria. About 50 items were sent out to the experts but were scaled down to a 40 items. Final copy of the instrument was produced with strict adherence to the observation made by the experts such as, 'questionnaire item statements should be made clearer and also replacing all the identified items that didn't pursued the objective of the study.'

The AAQ was administered on a sample of 40 students in a school that was not part of the study whose students demography in terms of age and class level were similar to the students involved in the main study. The reliability coefficient of AAQ was 0.68 using Cronbach's Correlation coefficient Statistics.

Two instructional strategies were used for the treatment administration processes which are Concept Mapping Strategy (CMS) and Lecture Method. The Concept Mapping Strategy (CMS) which was an adoption of Hall (2011) concept mapping model was used to teach experimental group on some selected algebraic concepts considered to be difficult to students in the WAEC

chief examiner's report 2017 such as: factorization of algebraic expression, quadratic equation and simultaneous linear equation by the researcher. This was done for a period of three weeks of 90 minutes lessons twice daily using Yin, Vanides, Ruiz-Primo, Ayala and Shavelson (2005) model of implementing concept mapping activities in the classroom which include the following steps:

**Step 1— Introduction:** Train the students if they have never created an open-ended type of concept mapping. The researcher drilled the students on how to construct concept mapping on a practice topic they are quite familiar with as they have never engaged in concept mapping construction. They were then given time to practice the construction of concept mappings on their own using a concept list related to the material taught in class provided by the teacher.

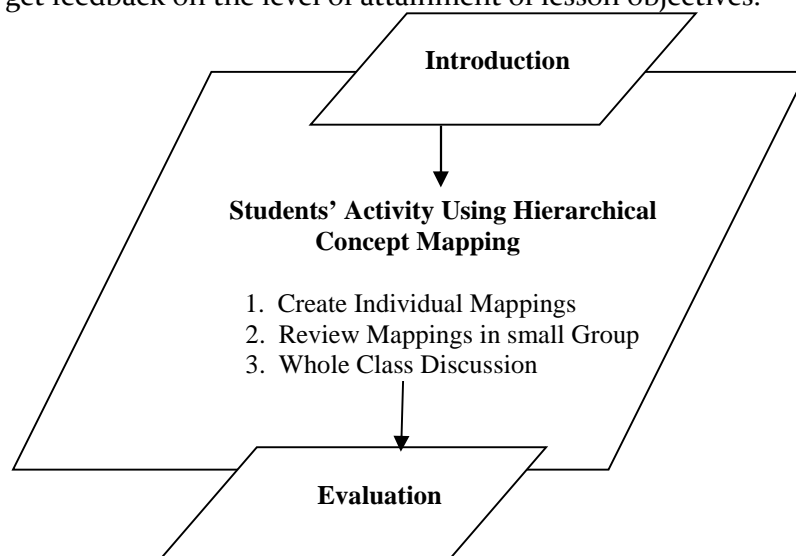
**Step 2— Students Activity Using Hierarchical Concept Mapping:**

**Activity 1:** Ask students to create their own individual mappings on the topic under discussion first using hierarchical model. This is to elicit the personal understanding of each student.

**Activity 2:** Organize students into small groups to discuss their individual concept mapping and have students share their concept mappings with partners, find similarities and differences in their mappings and try to reconcile them into a single mapping. These made them to articulate their thoughts and learn from each other.

**Activity 3:** Let the small group concept mappings be discussed in a whole class. This is done by asking the representative of each group to present and explain their concept mappings to the whole class. A whole-class mapping was created based on these discussions to document class progress. This was compared to the one constructed by the teacher on the topic such as the one presented in the appendix to widen the students' scope of understanding.

**Step 4— Evaluation:** Ask students questions on the lesson taught to know the students' level of understanding and get feedback on the level of attainment of lesson objectives.



Flow Chart of Concept Mapping Implementing Model in the Classroom

Source: Researcher (2016)

The group contains the low, medium and high ability level subjects. The control groups were also taught the same concepts by the researcher using lecture method for a period of three weeks of 90 minute lectures twice daily. Both the experimental the control group contain the low, medium and high ability level subjects.

The Algebraic Attitude Questionnaire (AAQ) was administered to the experimental and the control groups before and after treatment. The subjects were instructed to read the instruction on the questionnaire and respond appropriately depending on what they feel about each item. After completion, the questionnaires were collected from the subjects. The scoring for the items on the AAQ was based on the following pattern: Strongly Agree (SA) = 4 points, Agree (A) = 3 points, Disagree (D) = 2 points and Strongly Disagree (SD) = 1 point.

However, mean rank was used to analyze data to answer the research question since the data collected in respect of it were ordinal data. The formulated null hypothesis was tested by means of Friedman test and Dunn Bonferroni Analysis at 0.05 level of significance using version 20 of the Statistical Package for Social Sciences (SPSS).

The data obtained from the administration of AAQ were analyzed by means of descriptive and inferential statistics to answer the research questions and test the null hypotheses respectively using version 20 of the Statistical Packages for Social Sciences (SPSS) as follow:

**RQ:** What are the differences between the pretest and posttest attitude mean rank in algebra of low, medium and high ability level students exposed to concept mapping - strategy and those exposed to lecture method?

To analyse data to answer the research question, mean rank responses of students in the three ability levels before and after treatment were calculated as presented in Table 1.

**Table 1:** Pretest and Posttest Mean Rank Responses of High, Medium and Low Ability Level Students in Experimental and Control Groups

Group	Ability level	Test	N	$\bar{X}$ Rank	$\bar{X}$ Rank Diff.
Experimental	High Ability	Pretest	28	3.46	-5.84
		Posttest	28	9.30	
	Medium Ability	Pretest	42	2.83	-4.31
		Posttest	42	7.14	
	Low Ability	Pretest	63	2.54	-4.26
		Posttest	63	6.80	
Control	High Ability	Pretest	24	3.57	-1.09
		Posttest	24	4.66	
	Medium Ability	Pretest	33	2.65	-0.97
		Posttest	33	3.62	
	Low Ability	Pretest	50	2.58	-0.86
		Posttest	50	3.44	

The result of data analysis in Table 1 revealed that the difference between pre and posttest attitude mean rank response in high, medium and low ability levels in experimental and control

groups as presented in the last column of the table were in favour of posttest response in each of the three ability levels in both experimental control groups. This showed that the posttest mean rank in each of the three ability level of the two groups were higher than that of the pretest. However, there was slight difference between the posttest and pretest attitude mean ranking in each ability level in control group while in that of experimental group it was high. In order to establish if the differences are statistically significant, inferential statistics was used to test the null hypothesis.

### **Hypotheses Testing**

**H<sub>0</sub>** : There are no significant differences between the pre and post attitude mean rank in Algebra among low, medium and high ability level students exposed to concept mapping strategy and those exposed to conventional lecture method.

To test this hypothesis student's response in both experimental and control group before and after treatment were computed using Friedman test. The result is presented in Table 2

**Table 2:** Friedman Test Analysis of Students' Attitude Mean Rank in Algebra with Respect to Group and Ability Level Before and After Treatment

Group	Ability Level	Test	N	$\bar{X}$ Rank	$\bar{X}$ Rank Diff.	df	Chi-Square	P-value	Remark
Experimental	High	Pretest	28	3.46	-5.84	117	290.30	0.01	*
		Posttest	28	9.30					
	Medium	Pretest	42	2.83	-4.31				
		Posttest	42	7.14					
	Low	Pretest	63	2.54	-4.26				
		Posttest	63	6.80					
Control	High	Pretest	24	3.57	-1.09				
		Posttest	24	4.66					
	Medium	Pretest	33	2.65	-0.97				
		Posttest	33	3.62					
	Low	Pretest	50	2.58	-0.86				
		Posttest	50	3.44					

\* Significant at  $P < 0.05$

The result of data analysis in Table 2 showed a significant outcome on value  $P = 0.01 < 0.05$ . The null hypothesis  $H_0$  was rejected and the alternative hypothesis which stated that there are significant differences between the pre and posttest mean rank in algebra on attitude among low, medium and high ability level students exposed to concept mapping strategy and those exposed to conventional lecture method upheld. However, the post hoc testing base on Dunn Bonferroni analysis was further used to analyze the collected data as presented in Table 3.



**Table 3:** Dunn Bonferroni Analysis on Pair Wise Comparison of Students' Attitude Mean Rank Responses in Algebra with Respect to Group and Ability Level in Pretest and Posttest

Group	Ability level	Test	N	$\bar{X}$ Rank Diff.	P-value	Remark
Experimental	High Ability	Pretest	28	-5.84	.014	*
		Posttest	28			
	Medium Ability	Pretest	42	-4.31	.020	*
		Posttest	42			
	Low Ability	Pretest	63	-4.26	.003	*
		Posttest	63			
Control	High Ability	Pretest	24	-1.09	.951	**
		Posttest	24			
	Medium Ability	Pretest	33	-0.97	.218	**
		Posttest	33			
	Low Ability	Pretest	50	-0.86	.143	**
		Posttest	50			

\* Significant at  $P < 0.05$ \*\* Not Significant at  $P > 0.05$ 

The pair wise comparison in Table 3 showed significant differences between students Pretest and Posttest attitude mean rank in each of the ability level in experimental group in favour of Posttest, meaning that in each of the pair, the P value was less than 0.05 alpha levels. However, the difference in the attitude mean rank in each of the three ability level in control group was not significant meaning that in each of the pair, the P value was greater than 0.05 alpha levels.

## DISCUSSION

The result of Fredman test revealed that significant difference exist between pre and posttest attitude towards algebra among high, medium and low ability level students exposed to concept mapping strategy and those exposed to conventional lecture method. However, to further ascertain where specifically significant difference exist, Dunn Bonferroni analysis was used to analyzed the collected data as presented in Table 3 which established significant difference between the pretest and posttest attitude mean rank of students in each ability level in experimental group in favour of posttest compare to no significant difference established between the pretest and posttest attitude mean rank of students in each ability level in control group. This explains that there is significant impact of concept mapping on the attitude of students towards algebra. The implication is that concept mapping strategy is more effective in improving students' attitude towards algebra than the conventional lecture method. The active engagement of the learners provided by concept mapping strategy through self-construction of knowledge, group interaction, free discussion and making connection between concepts help to reduce the boredom usually associated with the use of lecture method and then, arousing their interest and developing their attitude positively towards algebra. This finding conforms to the study of Yunus (2010) but at variance with the finding of Kehinde and Emmanuel (2011). The finding also provides empirical

support to Kinchin (2011) and Horton, McConney, Gallo, Woods, Senn and Hamelin (2013) in recommending this innovative strategy.

## CONCLUSION

The results of this study have indicated that concept mapping teaching strategy is more effective in developing high, medium and low ability level student's attitude positively towards algebra compared to lecture method. Thus the strategy should be incorporated into the teaching of algebra at secondary school level. This in turn would enhance student's positive attitude in the study of algebra.

## RECOMMENDATIONS

Based on the findings from the study, the following recommendations are made:

1. The use of concept mapping strategy for teaching mathematics should be encouraged by government in our secondary schools to develop high, medium and low ability level students' attitude positively towards algebra.
2. Teacher training institutions such as Universities and Colleges of education that train secondary school mathematics teachers should incorporate the use of concept mapping strategy part of their mathematics teacher education curriculum to produce mathematics teachers who will promote the teaching of algebra through the use of concept mapping strategy.
3. The authors of secondary school mathematics textbooks should make concept mapping activities an integral part of their write up.

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