EFFECT OF CONCEPT MAPPING ON STUDENTS' ACHIEVEMENT IN TRIGONOMETRY: IMPLICATIONS FOR URBAN-RURAL MATHEMATICS

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Abstract

This study determined the efficacy of concept mapping in enhancing (he students' achievement in trigonometry. It also investigated the differential effect of concept mapping on the achievement of students in urban and rural schools. Two research questions and three hypotheses were formulated to guide the study. Data were collected from 297 SSII students using the Trigonometry Achievement Test (TAT). Concept maps, lesson plans on Sine and Cosine rules were used for the treatment. The results showed that students exposed to concept mapping strategy achieve higher in the trigonometry content than those who were not. Also, urban students scored significantly higher in achievement test than the rural students. The study recommended the adequate training of mathematics teachers on the use of concept mapping for classroom instruction.

Introduction

The importance of mathematics in all spheres of human endeavour cannot be overstressed. For instance, Ale (1994) remarked that mathematics is the backbone of knowledge. Mathematics is also described as the pivot of all civilizations and technological development (Eguavon, 2002). These descriptions are signal to the significant position accorded mathematics as a tool for development. Mathematics helps to enumerate, calculate, measure, collate, group and analyze data (Onugwu, 1991). When properly viewed, mathematics is a model for thinking, developing scientific structure, drawing of conclusions as well as for solving problems (Odo, 1999). The arguments above stress the fact that mathematics is not only a valuable subject, but also a vital tool in science, commerce and technology.

Unfortunately, despite the importance of mathematics as a key subject for realizing the nation's scientific and technological aspirations, there is ample evidence of continued poor achievement in mathematics nation-wide (Odili, 1992; WAEC, 1999). Also, reporting to the National Council on Education (NCE) about students' performance in the May/June SSCE, the West African Examination Council (WAEC, 1998) lamented the low performance by the Nigerian candidates in both urban and rural schools.

Empirical studies in mathematics education have not reached a consensus on school location as a factor in mathematics achievement. For instance, Jahun and Momoh (2001) investigated the effects of sex and environment on the mathematics achievement of Junior Secondary Three Students in Kaduna State. Jahun and Momoh reported that urban-rural factor has no influence on the performance of students in mathematics at that level. However, Odo (1999) reported that school location is a significant predictor of students' difficulties in aspects of mathematics. The study revealed that students in urban areas have less difficulties in mathematics compared to their rural counterparts. This is in agreement with similar studies (Jahun, 1989 & Okoye, 1994) which showed that students in urban schools had higher achievement in mathematics than the rural students.

Many reasons have been advanced for the dismal state of mathematics. While some researchers (AH, 1989 & Harbor-Peters, 1992) are of the view that teachers' incompetence are the contributing factors, other research findings (Adeniyi, 1988; Alio & Harbor-Peters, 2000) attributed the low performance in mathematics to teachers' non-utilization of appropriate instructional techniques. Most of the teachers use strategies that are known to them, even if these strategies are not relevant to the concept under discussion (Akinsola & Popoola, 2004). Surprisingly, most teachers still believe that the most effective means of communicating knowledge is via the conventional "talk and chalk" strategy (WAEC, 1996). Conventional methods of teaching, among others, include lecture and discussion, which are commonly used by teachers. In these conventional methods, the teacher writes on the chalkboard as he explains the steps. He gives take-home assignments to which corrections are done in the nexHesson. The students are not actively involved in the above instructional approach. Opara (1995) advised that teachers should evolve strategies that involve learners' active participation. Such strategies will enhance achievement in mathematics. In search of such a strategy the researcher decided to use concept mapping which has been reported to be effective in improving chemistry and Biology achievement (Ezeudu, 1995; Esiobu & Soyibo, 1995) respectively.

A concept according to the Oxford Advanced Learners Dictionary is an idea or a principle or a proposition. According to Novak and Gowin (1984) a concept is an abstract idea, proposition or principle that is not limited to one place or time, while a map is a kind of visual network showing some of the path ways we may take to connect things (Novak & Gowin, 1984). A concept map, according to Novak and Gowin, is a schematic device for representing a set of concept meanings embedded in a framework of propositions. It can also be defined as a device for showing the hierarchical relationship between concepts within the structure or segment of a discipline. Concept mapping is a metacognitive strategy. Metacognitive strategies as explained by Novak (1987) are strategies that empower the learner to take charge of his or her own learning in a highly meaningful fashion. These strategies include metalearning or learning about meaningful learning and metaknowledge or learning about the nature of knowledge.

The concept mapping strategy is based on AusubePs learning theory which emphasizes that meaningful learning occurs when new concepts are linked to familiar concepts existing in the learners' cognitive structure (Okebukola & Jegede, 1988). Literature is prolific on the efficacy of the concept mapping technique in enhancing the Learning and achievement in many subjects. For instance Esiobu and Soyibo (1995) investigated the effectiveness of concept mapping in facilitating learning and achievement in Ecology and genetics. Similarly, Ezeudu (1995) and Ezeugo (1999) carried out studies to determine the effect of concept maps in learning chemistry and algebra. They both reported that concept mapping strategy accelerated learning and achievement in the topics under consideration. Hence, how would concept mapping affect the achievement of students in trigonometry and to what extent does concept mapping affect the achievement of students from urban and rural schools in trigonometry.

Purpose of the Study

The purpose of this study was to investigate the effects of concept mapping on the achievement of SSII students in some trigonometric concepts. Specifically, the study investigated.

- The effects of concept mapping on achievement in sine and cosine rules.
- The effect of concept mapping on the achievement of urban and rural students in sine and cosine rules,
- The interaction effect of concept mapping with school location on students' achievement in trigonometry.

Research Questions

The following research questions were formulated to guide the study.

1. What are the mean achievement scores of students taught with concept mapping and those taught with the conventional technique in the Trigonometry Achievement Test (TAT)?
2. What are the mean achievement scores of urban and rural school students taught with concept mapping in the TAT?

Hypotheses

In order to further guide the study, the following hypotheses were formulated and tested at the 0.05 alpha level of significance:

i. There is no significant difference in the mean achievement scores of students taught with concept mapping and those taught with the conventional strategy. ii. There is no significant difference in the mean achievement scores of students in urban and rural schools taught with concept mapping. iii. There is ho significant interaction effect of concept mapping with school location on students' achievement in trigonometry.

Research Method

The study was a quasi-experimental study of a non-equivalent control group design. This design was adopted because it was not possible to have complete randomization of subjects. Intact classes were randomly assigned to experimental and control treatments. The sample consisted of 297 SS II students from eight classes randomly selected from four schools - two rural and two urban schools in the education zone B of Benue State.

Data was collected using the Trigonometry Achievement Test (TAT) developed by the researcher. Lesson plans based on concept mapping were utilised during the experimental treatment while the conventional methods were used for the control group. Both the concept maps and the lesson plans were validated by three experts in mathematics education. The TAT was developed based on the mathematics curriculum in trigonometry. It was also screened by the same experts as in the lesson plans. The TAT was trial tested on a sample of forty SS II students from a school in Makurdi. The reliability coefficient was computed using the Kudder-Richardson formula (K-R) 20 for the objective test and the inter-rater reliability for the essay part. The reliability coefficients obtained were 0.63 for the objective test while the essay part had 0.9.

Experimental Procedure

The researcher organized a training programme for the teachers who were used in the study. Intact classes were assigned to experimental and control groups. The pre-test was administered by the researcher before the commencement of the experiment. A graduate teacher who specialized in mathematics education with three years experience taught students in the experimental group while the control group students were taught by their regular teachers. The teachers administered the Post-Test after the experimental treatment. The research questions were answered using mean and standard deviation. The hypotheses were tested at 0.05 level of significance using the analysis of covariance (ANCOVA).

Results

The results of the study are presented in the following tables.

Table 1: The Mean Achievement Scores and Deviations of Students in the Experimental and Control Groups

Gr ou	N of o	PRE-T	SD	POST -TAT	SD
Ex peri me ntal	1 5 7	10.92 10.31	5.3 8 5.4 6	47.73 39.69 8.04	10.57 6.58

Table 1 shows that the mean achievement score of the experimental group in the POST-TAT was 47.73 with a standard deviation of 10.52. This mean is higher than that of the control group which was 39.69 with a standard deviation of 6.58. This gives a difference in mean achievement scores of 8.04 in favour of the experimental group. The Pre-TAT - Post-TAT gain of 36.81 (from 10.92 to 47.73) for the experimental group was also higher than that of the control group which was 29.38 (from 10,31 to 39.69). The experimental group therefore achieved more than their control group counterpart as a result of the use of concept mapping.

Table 2: **Two -Way** ANCOVA **Table of Subjects'** Scores **in Trigonometry Achievement Test (TAT)**

Source of		Adj Sum	Mea		R
M e t h o	l o c a t	4452.12 6913.65 750.19 13367.04 27S92.9	4452 .12 6913 .65 750.	9 5 . 5 9	S S s

Results in Table 2 indicate that the calculated F-value of 95.59 is greater than the F-critical value of 3.86 at the 0.05 level of significance. Thus hypothesis 1 of no significant difference in the mean achievement scores of subjects taught with concept mapping and those taught with the conventional method is rejected.

Table 3: Mean and Standard Deviation Scores **of Subjects in Urban and Rural Schools**

G r	T y	U r	S O	R u	SD
E x p e	P r e -	1 2 . 3	6 . 3 6	9 . 4 5	3.6 1 5.1 3

Table 3 shows that in the .Post-TAT, the urban subjects in the experimental group obtained a higher mean achievement score of 54.44 with a standard deviation of 5.02 compared to their control group counterpart who had a mean achievement of 43.41 with a standard deviation score of 5.59. A similar performance was observed with the rural subjects. The rural subjects in the experimental group obtained a higher mean achievement score of 40.75 with a standard deviation of 5.13 compared to their control group counterparts with a mean achievement score of 35.96 and a standard deviation of 5.27. However, comparing the achievement scores of the urban and rural subjects in theexperimental group, it is observed that the urban subjects obtained a higher mean achievement score of 54.44, while their rural counterparts had a mean achievement score of 40.75 and a standard deviation of 5. 13.

Table 2 reveals that school location has significant effect on students' performance in trigonometry when taught using the concept mapping technique.

The Calculated F-value of 148.44 exceeds the critical F-value of 3.86 at $P < 0.05$. Thus hypothesis 2 of no significant difference in the mean achievement scores of students in urban and rural schools taught using the concept mapping technique is rejected.

Also, results from Table 2 reveal that there is significant interaction effect of concept mapping with school location on students' achievement in trigonometry. The calculated F-value of 16.11 is higher than the critical F-value of 3.86 at $P< 0.05$.,Thus hypothesis 3 is rejected.

Discussion and Implication of the Findings

Results in Table 1 show that students in the experimental group had a higher mean achievement score in trigonometry compared to their control group counterparts. This is further confirmed by the results in Table 2 which indicate that the method is a significant factor in the mean achievement of students in trigonometry. This means that the students who were taught using the concept mapping strategy performed better than those who were taught using the conventional technique. Thus, the results reveal that the adoption of relevant instructional strategies will enhance meaningful learning of mathematics. This supports Okebukola's (1992) view that students demonstrated greater understanding as a result of exposure to the concept mapping strategy.

Again, from Table 3, the results show that the students in urban schools have a higher mean achievement scor.e compared with their rural counterparts in the experimental group. This is further confirmed by the results in Table 2 which indicate that a significant difference exists in the mean achievement scores of students in urban and rural schools in favour of the urban students. This result agrees with other findings (Okoye, 1994 & Odo, 1999) which stated that students in urban schools have less difficulties and fear for mathematics than those from rural schools. This means that those from urban schools will find the learning of mathematics more interesting and hence, perform better than their rural counterparts. This, also, agrees with the findings of Jahun (1989) who realized that urban students performed better than their rural counterparts in both forms of Ahmadu Bello University Achievement Test (ABUMAT). This result is however at variance with that of Jahun and Momoh (2001) which reported that urban - rural factor has no influence on the performance of students in mathematics at the Junior Secondary School Level. The interaction effect of method by school location was also significant. Thus, the difference in the mean achievement of urban and rural students was due to the instructional strategy adopted. Generally, the students-exposed to concept mapping strategy achieved greater than those who were not. Thus, concept mapping is a viable strategy for teaching mathematics.

Recommendations

The following recommendations were made based on the findings of the study.

1. Since concept mapping is found to be an effective strategy for improving students' achievement in mathematics, the mathematics teachers should accept it as one of the strategies to be used in mathematics classrooms.
2. Workshops/seminars should be organized for in-service mathematics teachers. This will enable them learn how to use the strategy in the teaching of mathematics.

3. Teacher training institutions should include the concept mapping strategy in their mathematics method course content. This will ensure the training of the pre-service mathematics teachers on the use of the concept mapping strategy.

Conclusion

The results of this study have shown that the concept mapping strategy enhanced students' achievement in trigonometry. Thus there is a positive relationship between the technique of instruction and students' skills in solving trigonometric problems.

The urban students in the experimental group had significantly greater gain in achievement than their counterparts in the rural schools. This study has provided the empirical evidence that mathematics is one of the areas where the use of concept mapping may be of immense benefit.

References

Adeniyi, N.E. (1988). Mathematics in Secondary Schools ABACUS 18(1), 89-106.

Ale, A. (1994). Mathematics Methods. In S.C.; Anih, S.O.; Olaitan, C.J.C.; Akubuilo, C.C.; Anadi, (Eds). Approaches to Creative Teaching. Onitsha: Summer Educational.

Eguavon, O.J. (2002). Mathematics the Heartbeat of Information Technology: Implication for Secondary Education. Journal of the Mathematical Association of Nigeria. 27(1), 10-12.
[n]v

Esiobu, G.O. and Soyibo, K. (1995). Effects of,Concept and Vee Mappings Under Three Learning Models on Students' Cognitive Achievement in Ecology and Genetics. National Association for Research in Science Teaching, 971-987.

Ezeudu, F.O. (1995). The Effects of Concept Mapping on Students' Achievement, Interest and Retention in Organic Chemistry. Unpublished Ph.D. Thesis, University of Nigeria, Nsukka.

Jahun, I.U. (1989). Construction and Standardization of Mathematics Achievement Test for Junior Secondary School Three Students in Kaduna, Kano and Katsina States of Nigeria. Unpublished Ph.D. Dissertation, ABU, Zaria, Nigeria.

Jahun, J.U. and Momoh, J.S. (2001). The Effect of Environment and Sex on the Mathematics Achievement of Junior Secondary School Three Students in Kaduna State. ABACUS: Journal of the Mathematical Association of Nigeria. 53 -5 8.

Novak, J.D. and Gowin, B.D. (1984) Learning How to Learn. New York: Cambridge University Press.

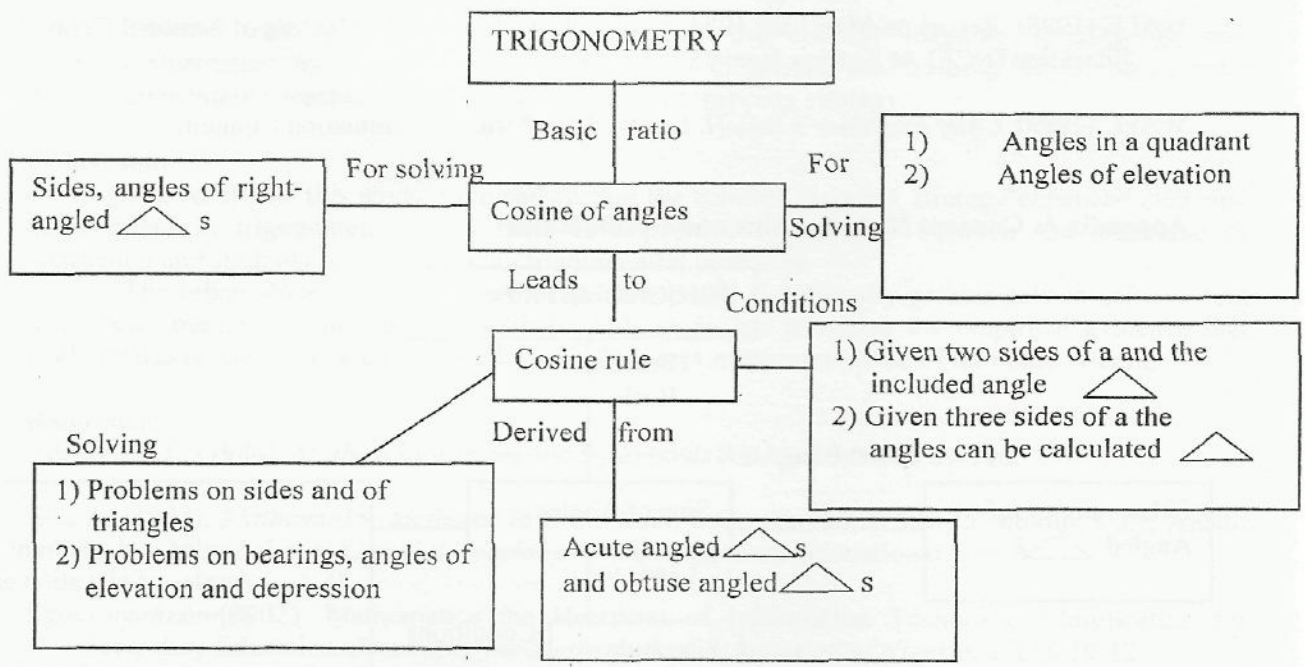
Novak, J.D. (1990). Concept.Maps and Vee Diagrams: Two Metacognitive Tools to Facilitate Meaningful Learning. Instructional Science, 19 (1), 29- 52. Learning How to Learn. New York: Cambridge University Press.

Odo, T.O. (1999). Gender and School Location as Factors of Students' Difficulty in Secondary School Geometry. Unpublished M. Ed. Thesis. Nsukka. Department of Education, University of Nigeria.

WAEC (1998). Report on May/June 1994, 1995 and SSCE to the 4[1'1] Meeting of National Council on Education (NCE) At Katsina from 23[rti] -27[th] February.

WAEC (1999). Chief Examiner's Report. Lagos: West African Examination Council. **Appendix A.**

Concept Maps for Sine and Cosine Rules

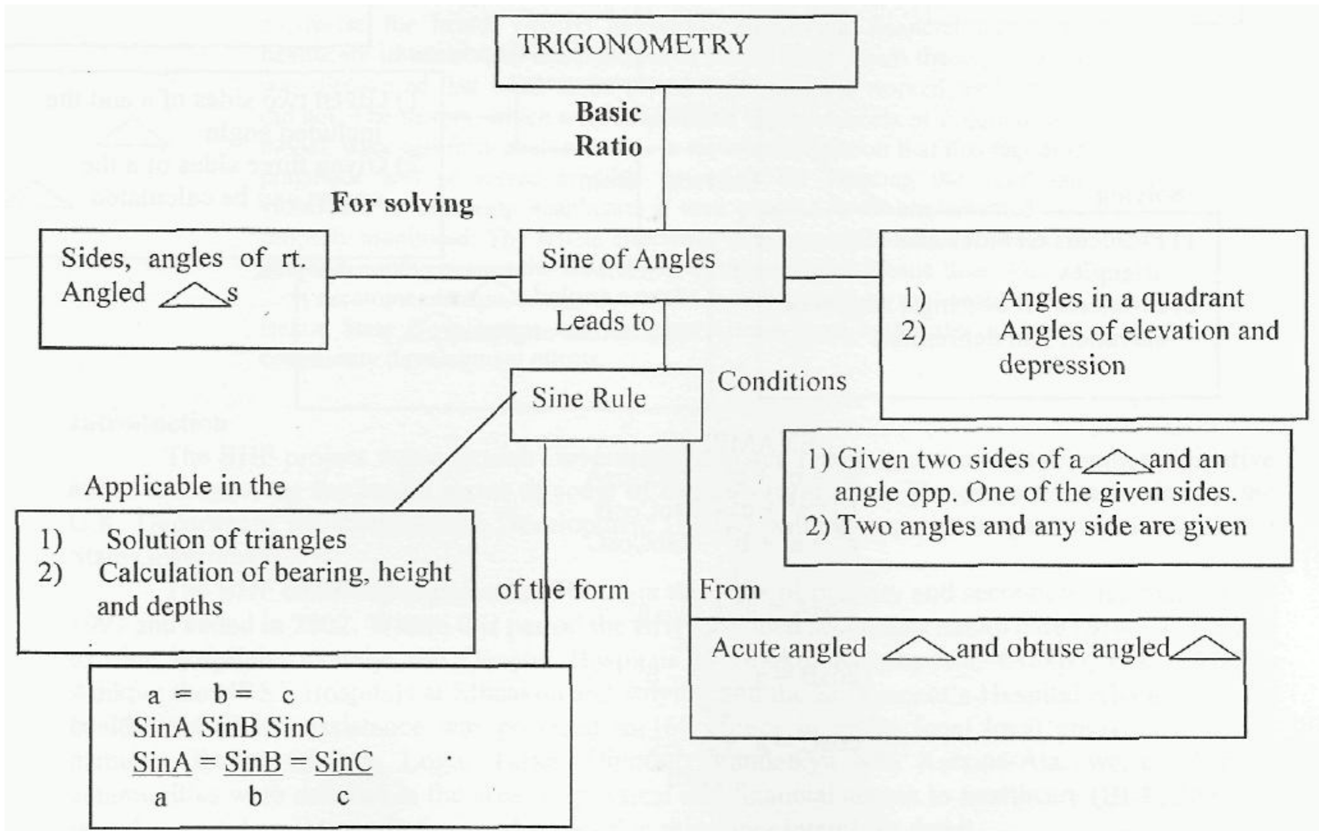


EXAMPLES:

$$a^2 = b^2 + c^2 - 2bcCosA$$
$$b^2 = a^2 + c^2 - 2acCosB$$
$$c^2 = a^2 + b^2 - 2abCosC$$

Or

$$CosA = \frac{b^2 + c^2 - a^2}{2bc}$$
$$cosB = \frac{a^2 + c^2 - b^2}{2ac}$$
$$cosC = \frac{a^2 + b^2 - c^2}{2ab}$$



TRIGONOMETRY
Basic Ratio
For solving
Sides, angles of rt. Angled △s
Sine of Angles
1) Angles in a quadrant
2) Angles of elevation and depression
Leads to
Sine Rule
Conditions
1) Given two sides of a △ and an angle opp. One of the given sides.
2) Two angles and any side are given
Applicable in the
1) Solution of triangles
2) Calculation of bearing, height and depths
of the form
From
Acute angled △ and obtuse angled △
a = b = c
SinA SinB SinC
SinA = SinB = SinC
a b c