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*Correspondence

Udowong Effiong Udowong

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Effect of Ethnomathematics-based Teaching Approach on Senior Secondary Students' Achievement in Trigonometry

Udowong, Effiong Udowong Ph.D.¹, and Abiam, Patrick Obere Ph.D.²

¹Department of Mathematics and Computer Science Education, University of Calabar, Calabar, **Nigeria**.

²Department of Science Education, University of Cross River State, Calabar, **Nigeria**.

Abstract

The study investigated the effect of ethnomathematics-based teaching approach on senior secondary school students' achievement in trigonometry in Calabar Education Zone of Cross River State, Nigeria. One research question and one research hypothesis guided the study. The study adopted quasi-experimental design of pre-test, post-test, non-equivalent control group. Stratified sampling technique was used to select a sample of one hundred and ninety-four (194) Senior Secondary One (SS 1) students for the study. This comprised ninety-eight (98) students for the treatment group and ninety-six (96) students for the control group. A validated, researcher developed 40-item multiple choice Ethnomathematics-based Achievement Test in Trigonometry (EMATTRIG) was used for the study. It had the Kuder-Richardson-20 reliability index of .89. Two sets of instructional packages were prepared, one for the treatment group and the other for the control group. The treatment group was taught trigonometry using the ethnomathematics-based teaching approach while the control group was taught using the conventional teaching method. Mean was used to answer the research question, whereas Analysis of Covariance (ANCOVA) was used to test the hypothesis. Results of the study indicated that ethnomathematics-based teaching approach showed more statistically significant indices than the conventional teaching method in enhancing students' achievement in trigonometry. Based on the findings, it was recommended that ethnomathematics-based teaching approach should be adopted in teaching trigonometry in Nigerian education system.

Keywords

Ethnomathematics, Teaching Approach, Achievement, Trigonometry, Mathematics.

Introduction

Education is an instrument used to bring desirable behavioural changes and all round development of an individual. Every educational system is guided by a curriculum. Mathematics being one of the several subjects that make the school curriculum cuts across all the disciplines. It is defined as the technique of discovering and conveying useful rules of reliable reasoning about

calculation, measurement and shape (Zaslavsky as cited in Udowong, 2020). Mathematics was introduced in the school curriculum to give the child opportunities for developing manipulative skills that will enable him/her function effectively in the society (Federal Republic of Nigeria, 2014). It is made compulsory in the primary and secondary school levels and a prerequisite for admission into most courses in tertiary institutions in Nigeria.

In spite of the importance of mathematics to human life, academic achievement in the subject has been relatively low in Nigeria over the years (Zalmon & Wonu, 2017). This trend is not different in Calabar Education Zone of Cross River State as Udowong (2021) reported that the average of 55.10% of students failed in General Mathematics in the West African Senior School Certificate Examination (WASSCE) from 2010 to 2018. Trigonometry is one aspect of mathematics that researchers and Chief Examiners have continually reported students' low academic achievement (Wonu & Zalmon, 2017; Usman & Hussaini, 2017; Sumaila & Bello, 2018; West African Examination Council, 2018).

The authors identified conventional teaching methods and teachers' emphasis on formulae and memorization as the root causes of the low achievement. Conventional teaching methods are based on the popular notion that Mathematics is universal and an abstract subject (Forbes, 2018). This is why the relevance of culture has been strangely absent in the traditional classroom in most Nigerian schools. It is based on the aforementioned, that the present study was based on ethnomathematics-based teaching approach.

Ethnomathematics-based teaching approach is the method of instruction which translates the foreign mathematics to suit the learners' background and experiences. It uses the learners' culture in conjunction with the Euro-centric mathematics. In Nigeria, enough empirical evidence has not been provided to justify the adoption of ethnomathematics-based teaching approach, especially in teaching the concept of trigonometry (Aikpitanyi & Eraikhuemen, 2017). However, the unique culture of the Efik people in Calabar Education Zone of Cross River State, Nigeria, which is apt and holds a huge mathematical significance that is largely untapped. The Efiks have trigonometric concepts like ekara, unioŋ, enuk/mfa, ndadaka, ibioŋ, nnen-nnen, nnen-nnen-mfa, and ikoso; meaning: circle, length, angle, line, horizontal, straightness, right-angle and triangle respectively (Enukoha, 1981). The people apply trigonometry in the construction of artifacts and buildings, designing patterns, farming practices, fishing and hunting practices (Udowong, 2020).

Studies have been conducted on ethnomathematics-based teaching approach and learners' achievement in mathematics. For instance, Unodiaku (2013) conducted a study to ascertain effect of ethnomathematics teaching materials on students' achievement in mensuration in Igbo-Etiti Local Government Area of Enugu State, Nigeria. A sample of 306 SS 2 students and a 15-item Ethno-Mathematics Achievement Test (ETHNOMAT) were used to collect data. Results from the study indicated that the mean achievement score of students taught mensuration with ethnomathematics materials was significantly higher than the mean achievement score of students taught with conventional approach.

Abiam, Abonyi, Ugama and Okafor (2016) investigated the effect of ethnomathematics-based instructional approach on primary school pupils' achievement in geometry in Boki Local Government Area of Cross River State, Nigeria using a sample of 420 Primary six pupils. Achievement Test in Geometry (ATG) was used to collect data. Results of the study showed among others, that the ethnomathematics-based instructional approach was superior to the conventional method in enhancing pupils' achievement in geometry.

Ubana, Abiam and Enun (2017) carried out a similar study in Yakurr Local Government Area of Cross River State, Nigeria. A sample of 304 Junior Secondary School One (JSS 1) students. A 20-item Geometry Achievement Test (GAT) was used to collect data. Results of the study indicated among others, that ethnomathematics-based teaching approach is significantly better than the conventional methods.

Ozofor and Onos (2018) conducted a study to ascertain the effect of ethnomathematics on Senior Secondary School students' achievement in probability in Ikwuano Local Government Area of Abia State, Nigeria. A sample of 84 SS 2 students was used. Mathematics Achievement Test on Probability (MATP) was used to collect data and the results of the study indicated that ethnomathematics approach was more effective in facilitating students' achievement in probability than conventional methods.

Fasasi and Yohanna (2018) investigated effect of ethnomathematics-based teaching approach on students' academic achievement in geometry and mensuration in Mubi Education Zone of Adamawa State, Nigeria. A sample of 313 SS2 students and Mathematics Achievement Test (MAT) were used in the study. Results of the study indicated that students exposed to ethnomathematics-based teaching approach achieved higher than those taught with conventional methods.

The above review showed that the present study is related to the studies reviewed in terms of methodology and results. However, none of the studies were conducted in Calabar Education Zone. Again, the studies were conducted in geometry, mensuration, statistics and probability. None of the studies were conducted in trigonometry.

Materials And Methods

The study adopted quasi-experimental design of pre-test, post-test, non-equivalent control group. The population for this study comprised the 4941 Senior Secondary One (SS 1) students in Calabar Education Zone of Cross River State, Nigeria (Cross River State Secondary Education Board, 2018). Stratified random sampling technique was used to select four schools for the study and simple random sampling technique was used to assign two schools each to the experimental and control groups. The sample for study was 194 Senior Secondary One (SS 1) students, comprising 90 males and 104 females.

A researcher-designed instrument was developed, titled Ethnomathematics-based Achievement Test in Trigonometry (EMATTRIG). It comprised two sections (A and B). Section A sought for demographic data. The Section B measured students' achievement in trigonometry, with 40 multiple choice items of four options each. Each item had one correct answer and three distracters.

The face and content validity of the instrument was ensured by two experts, one in Mathematics Education and another in Measurement and Evaluation. After the validation, Ethnomathematics-based Achievement Test in Trigonometry (EMATTRIG) was subjected to revision based on the corrections and recommendations of the experts. The content validity was ensured through a table of specification which served as a guide for the test development. The construction of the table of specification was based on the Senior Secondary One Mathematics Curriculum content (Federal Ministry of Education, 2007).

A trial testing of the revised EMATTRIG was conducted using 40 SS 1 students from two public secondary schools in Calabar Education Zone who were not part of the sample for the main study but however shared similar characteristics. The scores obtained from the trial testing were used to determine item difficulty, item discrimination and reliability indices. The item difficulty indices (from 0.38 to 0.68) and the discrimination indices (from 0.45 to 0.85) were considered satisfactory (Reynolds, Livingston & Wilson, 2009; Salisbury, 2014). The reliability was established using Kuder Richardson-20 (KR-20) analysis and was found to be 0.89. This index is considered high enough to guarantee confidence in the use of the EMATTRIG (Asika, 2012).

Furthermore, the researcher developed two sets of lesson plans. One was based on ethnomathematics-based teaching approach (for the treatment group) and the other was based on conventional teaching method (for the control group). Three experienced mathematics teachers were used to establish the suitability and conformity of the prepared lesson plans with the prescribed lesson format. The researcher then obtained permission from the principals of the schools that were used for the study and regular mathematics teachers in the participating schools were trained and used as research assistants.

After the training programme, both study groups were administered EMATTRIG as pre-test. Thereafter, regular mathematics teachers in the selected schools were used to teach the students using the prepared lesson plans. The same lesson units and contents were taught to the two groups. The students were taught during school hours as appeared in the class lesson time table. After four weeks of teaching, the instrument was reshuffled and administered as post-test to both experimental and control groups. Then the posttest was marked for both groups with the same marking scheme and the scores were collated.

Results

3.1 Research Question: What are the mean academic achievement scores of students in trigonometry before and after treatment with ethnomathematics-based teaching approach and conventional teaching method?

The results in Table 1 indicate that at pre-treatment, those subjected to ethnomathematics-based teaching approach had lower mean academic achievement score (7.153) compared to the mean academic achievement score of those taught using the conventional teaching method (7.552). On the contrary, students subjected to ethnomathematics-based teaching approach had higher mean academic achievement score (26.582) compared to the mean academic achievement score of those taught using the conventional teaching method (12.323) at post-test after treatment.

3.2 Research Hypothesis (HO): There is no significant difference between the mean achievement scores of students taught trigonometry using ethnomathematics-based teaching approach and those taught with conventional teaching method.

In Table 2, the results of the F-ratio test of the post-test treatment scores for the effect of covariate (pre-test scores) showed the overall effect model (corrected) was significant ($F = 725.523$, $P = .000$); the intercept, pre-test and teaching method were equally significant ($F = 966.774$, 733.043 , 759.004 ; $P = .000$). On the basis of this outcome, the null hypothesis was rejected. This means that there is significant difference in the mean achievement post-test scores of students taught trigonometry using ethnomathematics-based teaching approach and that of those taught with the conventional method.

Table 1: Descriptive Statistics of Pre and Post-treatment Achievement by Teaching Method

Session	Teaching method	N	Mean	Std. dev.	Standard error
Pre-treatment	Ethnomaths	98	7.153	6.854	.692
	Conventional	96	7.552	7.330	.748
	Total	194	7.351	7.078	.508
Post-treatment	Ethnomaths	98	26.582	4.756	.480
	Conventional	96	12.323	10.511	1.073
	Total	194	19.526	10.809	.776

Table 2: One-way Analysis of Covariance (ANCOVA) of Post-test Mathematics Achievement by Teaching Method

Source of Variation	Sum of squares	df	Mean Square	F-value	P-value
Corrected Model	19925.583	2	19925.583	725.523*	.000
Intercept	13275.616	1	13275.616	966.774*	.000
Pre-test	10066.049	1	10066.049	733.043*	.000
Method	10422.542	1	10422.542	759.004*	.000
Error	2622.788	191	13.732		
Total	96512.000	194			
Corrected Total	22548.371	193			

Discussion

The hypothesis of the study sought to determine whether there was a significant difference in the academic achievement of students taught trigonometry using ethnomathematics-based teaching approach and the conventional teaching method. The result of this hypothesis was significant; hence, the null hypothesis was rejected. This shows that there was significant difference in the mean post-test achievement scores of students taught trigonometry using ethnomathematics-based teaching approach and those taught with the conventional teaching method; in favour of ethnomathematics-based teaching approach.

This finding is in agreement with other studies (Abiam, Abonyi, Ugama & Okafor, 2016; Ubana, Abiam & Enun, 2017; Ozofofor & Onos, 2018; and Fasasi & Yohanna, 2018) who found that the use of ethnomathematics-based teaching

approach in teaching enhanced students' achievement in geometry, mensuration and probability than conventional teaching method. This finding is also in agreement with Vygotsky's social constructivist theory that students construct knowledge on the basis of their existing knowledge, which is related to their environment and culture. It is also in line with Skemp's theory of concept formation and communication in mathematics, that learners construct schemata to link what they already know with new learning. The higher achievement by the experimental group could be attributed to the cultural-based, activity-based and student-centred ethnomathematics-based teaching approach. Moreover, the students learned mathematics concepts by actively using materials common to their immediate environment and culture. By so doing, abstract and rote mathematics learning as well as mathematics phobia was overcome among the students.

Conclusion

Based on the findings of this study, the researchers concluded that ethnomathematics-based teaching approach enhances learners' learning and better achievement than the conventional teaching method. Based on the above conclusion, the researchers recommended that ethnomathematics-based teaching approach should be adopted by schools to enhance effective teaching and better achievement in trigonometry, and by extension, mathematics.

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