

EFFECT OF COLLABORATIVE INSTRUCTIONAL APPROACH ON STUDENTS' ACADEMIC PERFORMANCE AND SELF-CONCEPT IN TRIGONOMETRY IN BENUE STATE, NIGERIA

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Abstract

The study examined the effect of collaborative instructional approach on students' academic performance and self-concept in trigonometry in Education zone C of Benue state. The study answered two research questions and tested two hypotheses. The population of the study was 4587 Upper Basic Two (UBE 2) students within the study area. The sample size was 143 Upper Basic Two (UBE 2) students selected from four schools within Education zone C of Benue state using a multi-stage sampling technique. The study adopted a sample quasi-experimental non-equivalent pre-test, posttest control group design. Intact classes were randomly assigned to the experimental and control groups. Data were generated using two research instrument: Trigonometry Performance Test (TPT) and Trigonometry Self-concept Inventory (TSCI). The reliability of the instruments was established using Cronbach Alpha for TSCI with 0.71 obtained and Kuder-Richardson formula $20(K - R_{20})$ for TPT with 0.74 obtained. Mean and standard deviations were used to test the hypotheses at 95% alpha level. Results of the study among others revealed that there was a significant difference in the mean performance scores of students taught trigonometry using discussion method (DM). The study further revealed that there was significant difference in the mean self-concept ratings of students taught trigonometry using collaborative instructional approach and those taught using discussion method. It was recommended among others that Mathematics teachers should embrace the use of collaborative instructional approach in the teaching and learning of Mathematics to improve students' performance and self-concept.

Keywords: Collaborative instructional approach, Mathematics, performance and self-concept.

Introduction

The role of mathematics towards realizing the nation's scientific and technological aspirations is indisputable. It is the bedrock that provides the springboard for the growth of science and technology. This is because, adequate use of mathematics in modern science and technology is a sure way to harness all the natural, human, materials and economic resources of the nation. Onyema (2018) noted that no nation can advance higher than its level of scientific and technological development. Similarly, Onu and Onoh (2018) stated that mathematics is

an indispensable tool needed for the transformation of technological development to reality. Further, Alio and Eneze (2018) reiterated the fact that every nation needs mathematics for sustainable scientific and technological development. Edekor (2020) described mathematics as the supporting knowledge of modern sciences and a legitimacy label for all scientific knowledge. Edekor further opined that any knowledge which does not use mathematical rationality, techniques and language is over looked. This implies that the key to opening doors of scientific opportunities is a deep

understanding of mathematical concepts and procedures hence a meaningful understanding of mathematics is vital. This is what makes mathematics a compulsory subject at both primary and secondary school levels of education in Nigeria.

Mathematics is also used as a basic entry requirement into courses like medicine, architecture, engineering and other degree programmes. Hartman (2017) stressed that practically all careers and professions require the basic knowledge of mathematics as a pre-requisite. For instance, banking, marketing, medicine, law, engineering, computer science, technology and pharmacy require knowledge in mathematics. Mathematics knowledge and skills are also utilized in painting, music, management, information system, tailoring and carpentry. Hartman (2017) maintained that one cannot do without the use of fundamental processes in mathematics in daily life; an illiterate can get sometimes very well without learning to read and write, but he can never pull on without learning how to count and calculate. This explains the fact that mathematics is not only universally useful and utilitarian in nature; it is at the heart of human activities and key to the solution of human problems and hence, everybody needs it for survival.

In spite of the importance attached to mathematics, Iyi (2011) and Chief WAEC Examiners' Report (2017-2022) noted that there is persistent poor performance of students in both internal and external mathematics examinations. This calls for closer look into how the subject is taught and learnt. Several factors based on research evidence (Adewumi, 2012; Faroq & Shah, 2014; Sam-Kayode & Salman, 2015; and Sambo, 2015) have been advanced for this incessant poor performance among students in mathematics. For instance, Sambo (2015) identified poor teaching method as the major factor contributing to students' abysmal

performance in mathematics among others. Adewumi (2012) asserted that these factors are teacher related, attitude towards mathematics from both students and teachers and nonparticipation in mathematics classes.

Sunday Akanwu and Fajemidagba (2014) also identified teaching method used in mathematics as the major reason for persistent poor performance in mathematics. They maintained that the methods used are sterile and uninspiring and do not take into cognizance the learners' background knowledge. These methods lack adequate support and sufficient skills in trigonometry necessary for students' successful transition from upper basic level to senior secondary level which also could enhance students' performance in external mathematics examinations.

Although many factors affect students' self-concept and academic performance in mathematics, teaching methods have been found to be related to performance in several situations (Sarouphim & Chartouny, 2017). Self-concept as opined by Goldman and Penner (2014) is the set of knowledge and attributes that a person has about his/herself; the perception an individual assigned to him/herself, the characteristics or attribute that a person uses to describe himself/herself. In a similar view, Rubie-Davies and Lee (2013) declared that self-concept is the totality of a complex, organized and dynamic system of learned beliefs, attitudes and opinions that each person holds about his/her personal existence. Kung and Lee (2016) stated that self-concept is the basis for all motivated behavior because it gives rise to possible self and it is possible selves that create the motivation for behavior.

Sarouphim and Chartouny (2017) maintained that self-concept can be developed or constructed by individuals through

interaction within the environment and reflecting on that interaction. Thus, self-concept is a variable that can be enhanced in students through conscious efforts of the teacher and counselor. It is therefore, important to investigate how students' self-concept can be boosted through collaborative instructional approach of teaching and learning of trigonometry. The authors further stated that any student characteristics that can change because of training and exposure to counseling can be very important in enhancing students' academic achievement. Self-concept could hopefully encourage students to develop interest in the study of trigonometry and this could provide necessary information for provoking inquisitive spirit of upper basic mathematics students.

Trigonometry is an important branch of mathematics. It comes from two Greek words; "trigonon" meaning triangle and "metric" which is measurement. Therefore, trigonometry means measurement of triangle. Atanu (2016) traced the history of trigonometry back to 3000 years, where the Babylonians, the Greeks, and the Egyptians used to find the lengths of the sides of triangles and the measures of their angle. The science of trigonometry is based on certain ratio called trigonometric ratios. Trigonometric ratios of an acute angle are of three basic forms, "Sine, Cosine and Tangent" which can be defined in terms of the sides of a right-angled triangle. The early applications of the trigonometric ratio were for surveying, navigation and engineering which are very important tools for the development of any nation (Atanu, 2016). A study of trigonometry primarily involves concepts of triangles, the right-angled triangle and the unit circle but its applications include; Angle of elevation, Angle of depression, Bearing, Longitude and Latitudes to mention but a few.

As important as trigonometry is, it is the aspect of mathematics that students have difficulty in learning. Basic Education Certificate Examination (BECE) Chief Examiners' Report June/July (2017-2022) remarked that candidates' attempt on trigonometry questions were unsatisfactory in the BECE. According to Sam-Kayode and Salman (2015), this remark was as a result of lack of adequate knowledge of the subject matter and incorrect interpretations of trigonometry concepts and ideas arising from their prior knowledge. Therefore, the need for trying collaborative instructional approach in teaching trigonometry is necessary.

Zhang and Cui (2018) defined collaboration as an art of working with another person or group of people to create or produce something. In education, collaborative instruction is a learning process which involves interaction among individuals towards achieving a common goal. The approach stresses active participation and interaction among students. Van Leeuwen and Janssen (2019) noted that collaborative instructional approach helps students to decode difficult concepts and improve students' self-concept and performance.

The concept of collaborative instructional approach is often taken to be the same with co-operative learning. Co-operative learning is a discovery method in which small groups are used. It is a strategy where students work collectively in small groups by sharing ideas while working on a given task. Ali, Ahmed and Hussain (2021) defined collaborative instructional approach as a successful teaching strategy in which small teams, each with students of different levels of ability, use a variety of learning activities to improve their understanding of a subject. The authors further maintained that collaborative

instructional approach allows students in small groups to communicate with one another and it is believed that dialogue aids learning.

Collaborative instructional approach is an instructional strategy designed to bring all learners to a specific level of learning on a unit of instructions before being allowed to progress to the next unit of institution (Van-Leeuwen & Janssen, 2019). This approach involves providing quality instruction and testing.

However, the researchers wished to compare collaborative instructional approach with discussion method (conventional method of teaching). The researchers' choice of this conventional method is based on the reports of Olutola, Illiyas and Abdulsalam (2017) who reported discussion method of teaching to be a useful teaching technique for developing higher order thinking skills that will enable students to interpret, analyze, and manipulate information. Such evidence is scarce in the study area particularly in trigonometry. Hence, the need for this study.

Statement of the Problem

The crucial task in the field of mathematics education these days is the improvement in the teaching and learning process. For this purpose, within the last two decades a great deal of research efforts in mathematics education have been directed at strategies or techniques or approaches that may enhance teaching and learning of mathematics especially in primary and secondary schools. Methods like; the use of manipulative, interactive logo programming package, cooperative learning strategy (Uloko & Anyor, 2015), among others were explored for better understanding of learners. Though all these strategies were empirically tested and found effective, evidence of poor performance in mathematics by students still

re-occur as reports from chief examiners of Basic Education Certificate Examination (BECE) in Benue indicated poor performance in mathematics between 2017 and 2022, likewise the area of trigonometry is particularly noted. The problem of this study therefore is; what could be the effect of collaborative instructional approach on Upper Basic Two students' performance and self-concept in trigonometry.

Purpose of the Study

The purpose of this study was to examine the effect of collaborative instructional approach on students' academic performance and self-concept in trigonometry in Education zone C of Benue state. Specifically, the study sought to:

1. Determine the difference in the mean performance scores of students taught trigonometry using collaborative instructional approach and those taught using discussion approach
2. Ascertain the difference in the mean academic self-concept ratings of students exposed to collaborative instructional approach and discussion approach

Research Questions

The following research questions guided the study

3. What is the difference in the mean performance scores of students taught trigonometry using collaborative instructional approach and those taught using discussion approach?
4. What is the difference in the mean academic self-concept rating of students exposed to collaborative instructional approach and discussion approach?

Hypotheses

The following formulated hypotheses were tested at 0.05 levels of significance.

1. There is no significant difference in the mean performance scores of students taught trigonometry using collaborative instructional approach and discussion approach.
2. There is no significant difference in the mean academic self-concept ratings of students exposed to collaborative instructional approach and discussion approach.

Research Method

The researchers employed a quasi-experimental, non-equivalent pretest, posttest control group design where intact classes were used. The population of this study comprised of 4,589 (1,730 males and 2,859 female students) Upper Basic Education two (UBE 2) students in Benue Education Zone C in the 2021/2022 academic session (Universal Basic Education Board, 2021). Four schools were randomly selected using multi-stage sampling technique and used for data collection. One hundred and forty three UBE 2 students constituted the sample for the study.

Two instruments namely: Trigonometry Performance Test (TPT) and Trigonometry Self-concept Inventory (TSCI) were used for collection of data for the study. The TPT developed by the researchers consists of 30-items multiple choice questions with four options drawn from the topics in trigonometry based on the current Upper Basic Two mathematics curriculum. The TSCI was adapted from Marsh and Seaton

(2012) and modified. It contained 30-items designed to determine students' self-concept in trigonometry. The instruments were validated by three experts in mathematics education from Benue State University, Makurdi. They were trial tested on 32 UBE 2 students from a school outside those set out for the main study. The reliability coefficient of TSCI calculated using Cronbach Alpha yielded 0.71 while that of TPT calculated using Kuder Richardson formula 20 (KR-20) yielded 0.74. These reliability coefficients showed that the instruments were reliable (Musa, 2017). The instruments were administered on the students after permission from the principals was granted. The researchers engaged the mathematics class teachers of each school as research assistants who were trained by the researcher and adopted the direct delivery technique. They were collected on the spot by the research assistants under the guidance of the researchers.

Descriptive statistics of mean and standard deviations were used to answer the research questions while inferential statistics of Analysis of Covariance (ANCOVA) was used to test the hypotheses at 95% alpha level. The use of ANCOVA is considered appropriate to take care of the possible initial equivalence in the groups since intact classes were used for the study.

Results

Research Question One

What is the difference in the mean performance scores of students taught trigonometry using Collaborative Instructional Approach and those taught using Discussion Method?

Table 1: Mean and Standard Deviation Scores on Performance of Students in Collaborative Instructional Approach and Discussion Method.

Method		PreTPT	PostTPT	Mean Gain
Collaborative Instructional Approach	Mean	23.77	51.23	27.46
	N	73	73	
	Std. Deviation	8.85	10.43	
Discussion Method	Mean	20.47	40.36	19.89
	N	70	70	
	Std. Deviation	8.27	7.58	
Mean Difference		3.30	10.87	7.57

Table 1 shows the difference in the mean performance scores of students taught trigonometry using collaborative instructional approach and those taught using discussion method. The table shows that 73 students were taught trigonometry using collaborative instructional approach and 70 were taught using discussion method. The table further reveals that the mean performance scores of students taught trigonometry using collaborative instructional approach is 23.77 with a standard deviation of 8.85 during pre-test and 51.23 with a standard deviation of 10.43 in posttest. The mean performance scores of students taught trigonometry using discussion method is 20.47 with a standard deviation of 8.27 during pre-test and 40.36

with a standard deviation of 7.58 in posttest, Table 2 further shows that the mean gain of students that were taught using collaborative instructional approach is 27.46 and those taught using discussion method is 19.89. The difference in the mean performance gain scores of students taught trigonometry using collaborative instructional approach and those taught using discussion method is 7.57 in favour of students taught trigonometry using collaborative instructional approach.

Research Question Two

What is the difference in the mean academic self-concept ratings of students taught trigonometry using Collaborative Instructional Approach and Discussion Method?

Table 3: Mean and Standard Deviation Ratings of Self-concept for Students in Collaborative Instructional Approach and Discussion Method

Method		Pre Self Concept Rating	Post Self Concept Rating	Mean Gain
Collaborative Instructional Approach	Mean	2.47	2.66	0.19
	N	73	73	
	Std. Deviation	.18	.27	
Discussion Method	Mean	2.51	2.57	0.06
	N	70	70	
	Std. Deviation	.22	.26	
Mean Difference		0.04	0.09	0.13

Table 3 shows the difference in the mean self-concept ratings of students taught trigonometry using collaborative instructional approach and those taught using

discussion method. The table shows that 73 students were taught trigonometry using collaborative instructional approach and 70 were taught using discussion method. The

table further reveals that the mean self-concept ratings of students taught trigonometry using collaborative instructional approach is 2.47 with a standard deviation of 0.18 during pre-test and 2.66 with a standard deviation of 0.27 in posttest. The mean self-concept ratings of students taught trigonometry using discussion method is 2.51 with a standard deviation of 0.22 during pre-test and 2.57 with a standard deviation of 0.26 in posttest, Table 3 further shows that the mean gain of students that were taught using collaborative instructional approach is 0.19 and those taught using

discussion method is 0.06. The difference in the mean self-concept ratings gain of students taught trigonometry using collaborative instructional approach and those taught using discussion method is 0.13 in favour of students taught trigonometry using collaborative instructional approach.

Hypothesis One

There is no significant difference in the mean performance scores of students taught trigonometry using Collaborative Learning Approach and Discussion Method.

Table 2: ANCOVA Test on Mean Performance Scores of Students in Collaborative Instructional Approach and Discussion Method

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5536.539 ^a	2	2768.270	36.927	.000	.345
Intercept	26540.006	1	26540.006	354.026	.000	.717
PreTPT	1309.834	1	1309.834	17.472	.000	.111
Method	3243.534	1	3243.534	43.267	.000	.236
Error	10495.279	140	74.966			
Total	317425.000	143				
Corrected Total	16031.818	142				

a. R Squared = .345 (Adjusted R Squared = .336)

Table 2 reveals that $F(1, 140) = 43.27$; $p = 0.000 < 0.05$. Since p is less than 0.05, the null hypothesis is rejected. This implies that there is significant difference in the mean performance scores of students taught Trigonometry using collaborative instructional approach and those taught using discussion method. Thus, based on evidence from data analysis there is significant difference in the mean performance scores of students taught Trigonometry using collaborative instructional approach and those taught using discussion method. The

partial Eta square of 0.236 was obtained for the method meaning that 23.6% of the students' performance can be accounted for by the method employed in teaching Trigonometry.

Hypothesis Two

There is no significant difference in the mean academic self-concept ratings of students taught trigonometry using Collaborative Instructional Approach and Discussion Method.

Table 4: ANCOVA Test on Mean Self Concept Ratings of Students in Collaborative Instructional Approach and Discussion Method Classes

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	.313 ^a	2	.157	2.227	.112	.031
Intercept	4.873	1	4.873	69.309	.000	.331
Pre Self Concept Rating	.054	1	.054	.764	.384	.005
Method	.284	1	.284	4.040	.046	.028
Error	9.844	140	.070			
Total	987.609	143				
Corrected Total	10.157	142				

a. R Squared = .031 (Adjusted R Squared = .017)

Table 4 reveals that $F(1, 140) = 4.04$; $p = 0.046 < 0.05$. Since p is less than 0.05, the null hypothesis is rejected. This implies that there is significant difference in the mean self-concept ratings of students taught Trigonometry using collaborative instructional approach and those taught using discussion method. Thus, based on evidence from data analysis there is significant difference in the mean self-concept ratings of students taught Trigonometry using collaborative instructional approach and those taught using discussion method. The partial Eta square of 0.028 was obtained for the method meaning that 2.8% of the students' self-concept ratings can be accounted for by the method employed in teaching Trigonometry. Though significant, the strategy only improved on the self-concept of students minimally as it can only account for 2.8%.

Discussion of Findings

Findings on the use of collaborative instructional approach and discussion method revealed that there is significant difference in the mean performance scores of students taught Trigonometry using collaborative instructional approach and those taught using discussion method. This implies that the mean performance scores of students taught Trigonometry using collaborative instructional approach is

significantly different from those taught using discussion method. The finding agrees with that of Achor, Imoko and Jimin (2012) that students taught geometry using team teaching method gained significantly higher than those taught using conventional method. The adoption of collaborative instructional approach in the present study may have enabled the teacher and students to use co-operative efforts among students. This is because collaborative learning approach stresses active participation and interaction among students in small groups by sharing ideas while working on a given task. Findings on the use of collaborative instructional approach and discussion method revealed that there is significant difference in the mean self-concept ratings of students taught Trigonometry using collaborative instructional approach and those taught using discussion method. This implies that the mean self-concept ratings of students taught Trigonometry using collaborative instructional approach is significantly different from those taught using discussion method. The finding agrees with that of Hanan, Shabana and Mona (2016) that there was a significant statistical relationship between academic self-concept and students' performance among school age children.

The use of collaborative instructional approach in the present study enabled learners to engage in a common task with each individual depending on and accountable to the others. This may also be responsible for the significant difference found in the mean self-concept ratings of students taught Trigonometry using collaborative instructional approach and those taught using discussion method in the present study.

Conclusion

Based on the findings of this study, it was concluded that collaborative instructional approach enhances academic performance of Upper Basic two students in trigonometry. The study further revealed that collaborative instructional approach enhances students' self-concept in trigonometry.

Recommendations

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

1. School Administrators and inspectors in collaboration with Ministries of Education should encourage the use of collaborative instructional approach into mathematics classroom.
2. Ministries of Education, State Universal Basic Education Board and other relevant stake holders are encouraged to promote collaborative instructional approach by organizing regular conferences, seminars and workshops for serving teachers to acquaint themselves with the procedures for using collaborative instructional approach.

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