

Effect of Cooperative Learning Strategy on Students' Achievement in and Attitude to Mathematics

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Abstract

The study investigated the effect of cooperative learning strategy on senior secondary school students' achievement and attitude towards mathematics. A pre-test, post-test, control group quasi-experimental design with 2 x 2 factorial matrix (randomized, control group, pre-test, post-test) was employed. Two schools were randomly selected from Ibadan south-west Local Government Ibadan, Oyo state, Nigeria and the same sampling procedure was adopted for the selection of 200 senior secondary school students one (SSS1), 100 students from each school. Two instruments used were Mathematics Achievement Test (MAT) and Students' Attitude Scale (SAS). Descriptive statistics and Analysis of Covariance (ANCOVA) were used. The main effects treatments F (11.945) at $p < 0.05$ show that there is significant difference among the different groups, the cooperative group scored higher than the control group. Also, there is no significant interaction effect in the score of subjects on Achievement and attitude towards mathematics F (10.960) at $p < 0.05$. Based on the findings, it was recommended that Cooperative learning strategy should be adopted as a mode of instruction in secondary schools.

Keywords: Cooperative Learning, Attitude, Achievement, Mathematics

Introduction

Mathematics is an indispensable subject of study. It is a methodological application of matter. It is so said because the subject makes one systematic. Mathematics makes our life orderly and prevents chaos. Certain qualities that are nurtured through knowledge of mathematics are power of reasoning, creativity, abstract or spatial thinking, critical thinking, problem solving ability and even effective communication skill. One utilises the knowledge of mathematics in one form or the other on daily basis (Oni, 2019) because mathematics is the cradle of all creations, without which the world cannot move an inch. Be it a cook or a farmer, a carpenter, or a mechanic, a shopkeeper or a scientist everyone needs Mathematics in their day-to-day activities.

Mathematics plays an important role in forming the basic of all other sciences which deal with the materials, substance, space and time. Ukeje (2010) described the importance and the attention given to Mathematics as stemming from the fact that without Mathematics, there is no science, and without science, there is no modern technology and without modern technology, there is no modern society. Unameh, (2011) in Tshabalala and Ncube,(2013) was of the view that mathematics is bedrock and an indispensable tool for scientific, technological and economic advancement of any nation. Mathematics is not only made compulsory subject in the curriculum of the primary and secondary school levels of her educational system, but also as a pre-requisite to the study of science courses and admission to tertiary institutions (Oni, 2019). Again, the progress and development of a nation depends upon the volume of her scientific and technological advancements, which can only result from a sound Mathematics education, capable of making the citizens effectively functional in the field of pure and applied sciences. As Mathematics is the tool for science and technology, the report of poor performance in the subject is giving the public a serious concern, since it is viewed as a major impediment to the

technological transformation of Nigeria. The concern for this poor performance has not been limited to the mathematics and mathematics educators, it has also been the concern of parents and government. Mathematics education is confronted with serious problems which affect both male and female students and this could be traced to some factors, such as:

- i. School population explosion resulting in poor teachers' attention to students.
- ii. Inadequate pedagogical training of teachers resulting in poor teaching and learning.
- iii. Economic and socio-cultural background of students which sometimes result in lack of home support and poor interest in mathematics education.
- iv. Lack of text books and teaching aids
- v. Inadequate number of qualified and dedicated teachers
- vi. Negative attitudes of students towards mathematics
- vii. Poor instructional strategies
- viii. Language problem.
- ix. Difficulty paying attention.
- x. Lack of practice
- xi. Insufficient prior knowledge
- xii. Lack of well-developed mental ability etc.

The poor results of mathematics in both internal and external examination is not peculiar to Nigeria alone. It is world-wide (Akin Olajide, 2004). Some efforts have been made to improve the level of learning of mathematics in our society (Olusoji, 2003). Some educational associations such as Mathematical Association of Nigeria (MAN), Science Teachers Association of Nigeria (STAN) and a host of others have also continued to make efforts to popularize mathematics by organizing annual conferences where issues of contents, methodology and problems associated with mathematics are discussed with the intention of providing solutions to the problem. Also there is an annual mathematics competition for different stages of primary and secondary school pupils titled 'Mathematics Olympiad' organized by the Mathematical Centre it is also a remarkable step to identify and motivate young talents in mathematics. Apart from the above mentioned efforts, there are some text books that have been written to halt this negative trend among students and correct the erroneous belief widely held by students that mathematics is a difficult subject to pass. Some authors have carefully devised the means of introducing the subjects to the student in such a way that will make them develop positive attitude, interest, love and thus perform brilliantly in it (Omothoso, Adedokun & Abuduliah, 2003).

Attitude is an internal state that influences the actions of an individual. Attitude could be learnt or formed and acquired from members of the family, teacher and peer group. Attitude can be seen as the stable way in which a person reacts to people, things, situations and problem. There are lots of definitions of attitude but the central thing to all these definitions is the idea of readiness to response. Akinsola (1999) highlighted some attitudinal factors which contribute substantially to the difficulties encountered by students in learning and understanding mathematics which are:

- i. An expectation to assimilate new ideas without mental efforts.
- ii. Reluctance to devote time to the study and to practice.
- iii. The lack of persistence necessary to tackle exercise of non-trivial nature.

Attitude is an internal state that influences the actions of an individual. Gbore (2013) defined attitude as the totality of an individual's inclination towards object, institution or idea. According to Reid (2003), attitude expresses our evaluation of something or someone which may be based on our knowledge, our feelings or our behaviour, and may influence future behaviour. Reid

(2004) stated that attitudes are important to us because they cannot be neatly separated from study. Adesina and Akinbobola (2005) opined that attitudes could be acquired through learning and can be changed through persuasion using variety of techniques. Omotayo (2002) stated that students bring into classroom acquired attitude which could hinder or facilitate learning. The famous Chike Obi (a professor of mathematics in University of Ilorin, Nigeria), first encountered problems in the study of mathematics, but he changed his attitude towards it and determined to succeed. Today, he is an expert in mathematics. It has been realised that many students have developed negative attitudes towards the study of Mathematics which has led to poor performance of students in the subject.

The traditional method such as lecture method used by teachers has actually made the learning of the subject difficult thus affecting students' performance in both internal and external examinations. The circle of students' poor performance in mathematics needed to be broken which is the major concern of this paper. Basically, in the school system, students interact with one another as they learn together in three ways. One, they do compete with one another to know the best student perhaps for praise, grade and recognition. Again, students work individually towards a goal not minding how others do. Lastly, students can work cooperatively with the interest and mind of 'Together we succeed'. But in most institutions, competition is most dominant among the three ways. Conventional classroom environment is competitive most of the time. Students work independently on their own and often in competition with one another.

Cooperative learning is as old as research. The first research study came about in 1889, in the mid-1960s, cooperative learning was relatively unknown and largely ignored by educators (Johnson & Johnson, 2017). They further stressed that cooperative learning is presently used in schools and universities in every part of the world, for students of all ages. This is 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. Each member of a team is responsible not only for learning what is taught but also for helping teammates learn, thus creating an atmosphere of achievement.

Cooperative learning has been acknowledged in educational research as a successful pedagogy to improve students' academic achievement (Oni, 2005). The Cooperative Learning paradigm has set very high expectations that students can understand course content by taking responsibility for their learning. Cooperative Learning entails instructional methods in which the teacher organizes students into small groups, who then work together to help one another learn academic content. According to Good, Graws, Mason, Slavings and Cramer (1990) small groups can allow students to be more active and enable teachers to introduce more thinking and more challenging content into the curriculum. However, Kutnick (1990) cautioned that not all relationships among peers promote either cognitive development or friendship, but the interaction has to be directed or controlled by the teacher for effectiveness. Various empirical reports have suggested the positive effects of group work in mathematics and science classroom (Good et al 1990; Kempa & Ayob, 1985). Critics of cooperative learning strategy have commented on its impracticability with large class which is the prevalent situation with most Nigerian classes. Most teachers agree in principle with this approach but give excuses of not using it due to the large number of students which they have to face. Channon and Walker (1984) tried the cooperative learning strategy with large classes of students and the results showed enthusiasm and understanding of the mathematics concepts. They proposed that cooperative learning approach can be fully implemented with large groups of students if properly planned. When we compare cooperative learning with individualistic or competitive learning, it is more complex because it requires students to engage in learning tasks and work together. Therefore,

cooperative learning rarely succeeds in a situation where group members do not know how to manage the group particularly well, when it comes to resolving conflicts among group members. As part of cooperative learning condition, students are required to interact verbally with one another on learning tasks, exchange opinions, teach others, help the group operate well and take care of one another. Therefore, the present study is based on the investigation of effect of cooperative learning strategy on senior secondary school students' achievement and attitude towards mathematics with respect to improve the performance of secondary school students in mathematics.

Statement of the Problem

The dwindling general performance of students in mathematics has been a source of concern to all stakeholders the parents, teachers, students, government and the general public. A number of factors such as the instructional materials supplied, utilization of instructional materials, gender factors and attitude of the students to mathematics, teachers' mastery of content, and teaching pedagogy have been identified as contributing to this poor performance. All these factors that affect students' achievement in mathematics have been an area of interest for researchers over the years. Many attempts have been made to improve the learning of the subject such as the provision of a better teaching approach. This study, therefore, investigated the effect of cooperative learning strategy on senior secondary school students' achievement and attitude towards mathematics.

Hypotheses

Ho1: There is no significant main effect of treatment on

- (a) Students' achievement in mathematics
- (b) Students' attitude towards mathematics

Ho2: There is no significant main effect of gender on

- (a) Students' achievement in mathematics
- (b) Students' attitude towards mathematics

Ho3: There is no significant interaction effect of treatment and gender on

- (a) Students' achievement in mathematics
- (b) Students' attitude towards mathematics

Methodology

This study employed a pretest, posttest, quasi-experimental design, with a 2x2 factorial design. It is thus represented as follows:

O1 X1 O2

O3 X2 O4

X1-Experimental (Cooperative learning).

X2- Control group (conventional method)

O1 O3 are pre-test scores for the two groups.

O2 O4 are post-test scores for the two groups.

Sample and Sampling Technique

A purposive sampling technique was used to select two hundred students from two schools in Ibadan south/west local government based on the following criteria:

- i. School with qualified and regular teachers in mathematics.

- ii. Schools which have been presenting candidates for West Africa Senior School Certificate Examination (WASSCE) and National Examination Council (NECO) for at least 15years.

Simple random sampling was used to select classes from a Senior Secondary School one (SSS1). Therefore, the sample size for the study consisted of 200 Senior Secondary School one (SSS1) students offering mathematics from two government-owned secondary schools in south/west Local Government Ibadan. 100 students from one school were used for the experimental group (cooperative learning) while 100 students from the second school were used for the control group (conventional method).

Instrumentation

Two instruments were developed by the researcher namely:

- i. Mathematics Achievement Test (MAT)
- ii. Students Attitude Scale (SAS)

In (MAT) the Blooms Taxonomy of educational objective was used to guide the structure of the items in the instrument. These items were drawn in line with Nigeria's mathematics curriculum for Senior Secondary school (SS 1). This was done to test student's cognitive ability in mathematics. Therefore, 50-item multiple choice mathematics achievement test with four options per item was constructed and the duration set for students to answer these questions was 1hour. Also, the SAS instrument contained twenty-five items to elicit information on students' attitude towards mathematics.

Treatment

The treatment involved cooperative learning strategy for group 1 (Experimental group) and the conventional (lecture) method for group 2 (Control group)

Group 1 (Experimental group)

This group was exposed to cooperative learning strategy based on group method. There were 20 groups consisting 5 students in each group i.e students with different level of academic abilities to use a variety of learning activities to improve their knowledge in mathematics. Five topics (Indices/ Logarithms, Change of subject formula, Statistics) were given to them to take care of among each group. The teacher then introduces the subject matter to the students stressing the need to work together as a group on each lesson. The teacher also ensures prompt collection of the textual booklets at the end of each lesson. This exercise lasted for six weeks.

Group 2 (Control group)

The control group where there are 100 students in intact class (class A: 50, class B: 50) were exposed to conventional (lecture) method of teaching mathematics. In this group, teacher delivered his lesson using chalk and chalkboard. Teacher explained the topics to students and his focus is on knowledge transmission in an effort to cover the content within stipulated period. Students are passive in this group because it is teacher centered method of teaching though teacher asks questions to keep the students attentive.

Validity and reliability of instruments

Mathematics Achievement Test (MAT) was given to regular West Africa Senior School Certificate Examination (WASSCE) and National Examination Council (NECO) examiners for content validity. Also, Students Attitude and Characteristics Inventory Scale (SACIS) instruments were given to experts in the International Centre for Educational Evaluation (ICEE) University of Ibadan, Nigeria for both face and content validity. The criticisms proffered by

these expects actually guided the final draft of the instruments. Cronbach Alpha was used to establish reliability coefficient of the instruments value 0.72 and 0.71 respectively.

Procedure for Data Collection

In order to conduct the experiment successfully, the Mathematics Achievement Test (MAT) instrument was administered as pre-test to the students in the two groups (experimental and control group) in order to determine the entry behavior of the students in mathematics. In this case, students are to circle the correct option in the instrument. It was after this that the proper treatment began for both experimental and control group. The researcher spoke with the students and explained the purpose of the study. Besides that, two teachers were engaged and trained as research assistants. These teachers were given lesson plan on the selected topics to be used for six weeks based on the experimental treatment using cooperative learning strategy and the control using conventional (lecture) method. Students in both groups were monitored and guided throughout the period. At the end of the exercise, Students Attitude and Characteristics Inventory Scale (SACIS) instruments were administered to students and Mathematics Achievement Test (MAT) as post- test was administered in order to see the performance of the students in both groups.

Method of data analysis

The analysis of the data collected was done using descriptive statistics such as mean and standard deviation and analysis of covariance (ANCOVA).

Results

Table 1 Descriptive Statistics of Students Post-achievement Test Scores under each Treatment.

Group	N	X	S.D
Cooperative	100	18.73	4.44
Control	100	15.49	3.92

Note: N = no of subjects
X = means achievement score for post-test.
S.D = Standard deviation

Table 2

Summary of Analysis of Covariance (ANCOVA) of students Achievement scores of cooperative learning post test

Source	Sum of squares	df	Mean square	F	Sig
Sex	107.459	1	107.459	16.199	0.007*
Treatment	124.412	1	124.412	11.945	0.013*
Sex treatment Group	3.313	1	3.313	0.827	0.529Ns

Ns = not significant at $p > 0.05$

*= significant at $p < 0.05$

Table 3

Summary of Analysis of Covariance of Students Attitude Scale (SAS)

Source	Sum of squares	df	Mean square	f	Sig.
Sex	178.153	1	178.153	.417	.636
Treatment	63.374	1	63.374	.204	.756
Sex*Treatment	569.017	1	569.017	2.874	.338

Findings of the Results

Ho1a: There is no significant main effect of treatment on achievement of students exposed to different learning method.

From table 1, the result shows that the post-test mean scores of students exposed to cooperative learning ($X=18.73$) is higher than students in the control group ($X=15.49$). To test the significant mean difference, table 2 reveals the result from Analysis of Covariance that there is significant main effect on subject scores base on their post test scores after treatment (i.e after exposure to cooperative learning strategy 11.945 at $p < 0.05$) which shows that there is significant difference among the different groups. In this value of f-ratio the decision was to reject the null hypothesis which says there is no significant difference in the achievement of mathematics among students exposed to the cooperative and conventional method.

Ho1b: There is no significant main effect of treatment on students' attitude towards mathematics.

Table 3 shows that there is no significant difference on the attitude of students after exposure to the treatment. To test the significant mean difference, Table 3 reveals that the result from analysis of covariance that there is no significant main effect on subjects scores after exposure to cooperative learning strategy $f(.204)$ $p < 0.05$ f test shows that there is no significant difference in the attitude of subject after exposure to treatment. The decision was to accept the null hypothesis which says there is no significant difference in the attitude of subject exposed to the cooperative and control.

Ho2a: There is no significant main effect of gender on students' Achievement

From Table 2 the result reveals from Analysis of Covariance that there is significant main effect on the gender scores based on the post-test scores after treatment $f(16.199)$ at $p < 0.05$, shows that there is significant main effect of gender students' on achievement.

Ho2b: There is no significant main effect of gender on students' attitude.

From table 3 the result shows that there is no significant effect of gender on attitude of subject. F-ratio $f(0.417)$ at $p > 0.05$ shows that there is no significant main effect of gender on attitude. Therefore, the decision was to accept the null hypothesis which says there is no significant effect of gender an attitude.

Ho3a: There is no significant interaction effect of treatment and gender on students' achievement Based on the result from Table 2 which shows that there is no significant interaction effect in the scores of subjects on achievement towards mathematics. $F(0.827)$ at $p > 0.05$ which means there is no significant interaction effect of treatment and gender on achievement. The decision is to accept the null hypothesis above.

Ho3b: There is no significant interaction effect of treatment and gender on students' attitude.

Based on the result from Table 3 it shows that there is no significant interaction effect of treatment and gender on attitude $f(2.874)$ at $p > 0.05$ the decision is to accept the above null hypothesis.

Discussion of Findings

Based on the above findings, cooperative learning which is an instructional strategy in which small groups of students work together on a common task has been found useful in the learning of mathematics as it can be seen in the post-test scores of the students exposed to cooperative learning in the study. The finding is in line with Johnson & Johnson (2017) assertion that how teachers' structure student-student interaction pattern has a lot to say about how students learn. It means how students interact with each other should not be a neglect aspect of instruction. For attitude towards mathematics, it was found out that cooperative group performed better since

cooperative interaction provided social interaction, which enhanced confidence and positive attitude towards the subjects.

The findings of this study also corroborated with Tripathy (2004) who advocated that when the cooperative group situation is used, it could create a non-threatening environment in which students can more readily take academic risks. Tripathy further stressed that students who are working in groups are more likely to stay on task and remain motivated because of peer support and encouragement. This finding also is in line with Papanastasiou (2000) assertion who claimed that students with positive attitude towards mathematics will generally excel at it. The finding of this study agrees with the practice of educational theories that cooperative learning strategy enhances cognitive and affective outcomes. It has noted that the way mathematics is taught in our secondary schools is far from the expectation. Through cooperative learning strategy, students can be helped to develop more positive attitude towards mathematics.

Conclusion

The cooperative learning strategy has been found in this study to promote the students cognitive achievement in mathematics. The treatment further improved and strengthens the cognitive achievement outcome of the students as a result of social interaction that occurred within the group during the time of learning. Positive attitude towards mathematics will go a long way in the students' performance.

In conclusion, it is suggested that cooperative learning strategy should be adopted as modes of instruction to replace the conventional method which dominate our secondary schools. Again, the research also suggests that cooperative learning strategy can be combined with another learning strategy for more effectiveness.

Recommendations

Based on findings of the study, the following recommendations were made:

1. Cooperative learning strategy should be adopted as mode of instruction, since the result of the study shows that cooperative learning helps students' achievement.
2. The Federal and State Ministries of Education and other educational bodies like Nigeria Educational Research and Development Council (NERDC) and the Science Teachers Association of Nigeria (STAN) should organize training/ workshops for mathematics teachers. This could be done in order to update their knowledge on the use of the cooperative learning instructional strategy to improve teaching and learning in Nigerian schools.
3. The curriculum developers should design a curriculum based on cooperative learning strategy in teaching mathematics in our secondary schools. Also mathematics teachers should be encouraged to adopt cooperative learning strategy in order to enhance the cognitive learning outcome of students in mathematics.

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