

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' attitude and achievement 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 for the study. The subject for this study comprise of 200 senior secondary school students, 100 from each two randomly selected schools in Ibadan, Oyo state, Nigeria. Two instruments were used to generate data for the study. They are Mathematics Achievement Test (MAT) and Student Attitude and Characteristics Inventory Scale (SACIS). The participants responded to 50 items on an achievements test and 25 items on an attitude scale. Data analysis involved the use of descriptive statistics and Analysis of Covariance (ANCOVA). The highlights of the results are as follows; for 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. Again, there is significant main effect on the gender score on achievement, while there is no significant main effect on gender attitude score after treatment. Also, there is no significant interaction effect in the score of subjects on attitude and achievement towards mathematics F (10.960) at $p < 0.05$. Cooperative learning strategy should be adopted as a mode of instruction in secondary schools. Again, seminars, workshops, conferences and symposia should be organized for teachers and student teachers in order to expose them to cooperative learning.

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 preventing chaos. Certain qualities that are nurtured through knowledge of mathematics are power of reasoning, creativity, abstract or spatial thinking, critical (Zhou & Deng, 2017) thinking, problem solving ability and even effective communication skill. 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.

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. From the societal perspective, Mathematics competence is essential for the preparation for an informed citizenry and necessary for the production of highly skilled personnel required by industry, technology and science without which a nation in the modern world cannot progress or become economically independent (Adesina, 2001).

Mathematics has been highly rated among others, and for that reason, it has been described as the queen of all sciences and servant to all disciplines (Fakuade, 1976). Perhaps, it is as a result of this that the Federal Government of Nigeria under the auspices of the curriculum planning body of the Federal Ministry decided to make Mathematics a core (compulsory) subject. Nigeria in her march towards technological breakthrough has made Mathematics a compulsory subject in the curriculum of the primary and secondary school level of her Educational system Federal Ministry of Education (2013). 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 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.

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Sometimes teachers have serious defects in verbalizing concepts. Many of the concepts and terms in mathematics, which requires precise understanding are difficult to express in Nigerian language. 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). Curriculum organizations 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 content, 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.

Moreover, the importance placed on mathematics is reflected in the way parents and guardians shows concern in the performance of their wards in mathematics, even when they cannot afford to pay for extra lesson in other subjects, they often strive to pay for extra lessons in mathematics (Graham-Brown, 1996).

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 interest, love and thus perform brilliantly in it (Omothoso, Adedokun, & Abuduliah, 2003).

The indispensable role of attitude in the learning of Mathematics has garnered the attention of educational researchers and Mathematics educators for a very long time (Mensal, Okyere & Kuranchie, 2013). 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. It has also been realized that many students have developed negative attitudes towards the study of Mathematics which has led to poor performance of students in the subject.

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. No wonder Good (1973) stated that attitude is a mental or emotional readiness to respond to situations, persons or things. Emotion is attitude based. The negative emotions may thus lead to stress which diminish the ability to think clearly which will invariably affect understanding of mathematics. Akinsola (1999) affirmed that lack of understanding may lead to frustration and when one is frustrated, it's unlikely that one will be able to reach set goals, which will result in failure. Akinsola (1999) highlighted some attitudinal factors which contribute substantially to the difficulties encountered by student 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.

It has been observed that the traditional method such as lecture method used by teachers has actually made the learning of the subject difficult thus affecting their 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, 2015). 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 well documented in educational research as a successful pedagogy to improve students' academic achievement. 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, 1991).

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

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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.

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' attitude and achievement towards mathematics.

Hypothesis

Ho1: There is no significant main effect of treatment on

- (a) Achievement in mathematics
- (b) Attitude in mathematics

Ho2: There is no significant main effect of gender on

- (a) Achievement in mathematics
- (b) Attitude in mathematics

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

- (a) Achievement in mathematics
- (b) Attitude in 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 schools for the study from 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 15 years.

Simple random sampling was used to select an intact class from a Senior Secondary school (SS). Therefore, the sample size for the study consisted of 200 Senior Secondary school one (SS1) 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 and Characteristics Inventory Scale (SACIS)

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 1 hour. Also, the SACIS instrument contained twenty-five items to elicit information on students' attitude towards mathematics.

Treatment

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

Experimental Group 1

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, Approximation, Change of subject formula, Statistics and Simple interest) 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.

Control Group 2

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.

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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 experts actually guided the final draft of the instruments. The 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 assistance. These teachers were given lesson plan on the selected topics which 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 the both groups.

Method of Data Analysis

The analysis of the data collected was done using descriptive statistics and analysis of covariance (ANCOVA).

Results

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 1: Descriptive statistics of students post-achievement test scores under each treatment.

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

Table 2: Summary of Analysis of Covariance of students Achievement scores of cooperative learning post test
 Ns = not significant at $p > 0.05$
 *= significant at $p < 0.05$

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

Table 3: Summary of Analysis of Covariance of students attitudinal score (SACIS)

Findings of the Results

Ho-1a: 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 expose to cooperative learning strategy 11.945 at $p < 0.05$) which shows that there is significant difference among the different group. 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 control group.

Ho-1b: There is no significant main effect of treatment on attitudinal of student learning method.

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.

Ho-2a: There is no significant main effect of gender on Achievement

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

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

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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 on attitude.

Ho-3a: There is no significant interaction effect of treatment and gender on achievement

Base 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.

Ho-3b: There is no significant interaction effect of treatment and gender on attitude.

Base 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. This 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 is expected that cooperative group will be better since cooperative interaction will provide social interaction, which may enhance 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. He 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. 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. 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. The study provides empirical evidence on the effectiveness of cooperative learning strategy in enhancing academic achievement of students in mathematics. This implies that the use of cooperative learning strategy of mathematics can improve poor performance of students in mathematics.
2. Cooperative learning strategy should be adopted as mode of instruction, since the result of the study shows that cooperative learning helps students' achievement.
3. 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.
4. 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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