

THE EFFECT OF COOPERATIVE LEARNING METHOD ON SECONDARY SCHOOL STUDENTS' ACADEMIC ACHIEVEMENT IN MATHEMATICS

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Abstract

The study examined the effects of cooperative learning method on secondary school students' academic achievement in mathematics in Edo State. The study employed a quasi-experimental pre-test post-test non equivalent control group design method. senior secondary school students in Edo State. Three research questions and three null hypotheses were formed to guide the study. 288 (147 males, 141 females) Senior Secondary School Students were sampled from a population of 11,287 students. The sampled students consisted of 160 students in the treatment group and 128 students in the control group. The treatment group was taught mathematics using cooperative learning method while the control group was taught using the conventional method. The instrument used for the collection of data was Mathematics Achievement Test (MAT). The test contained 40 multiple choice questions. The instrument was validated by a team of experts. A reliability co-efficient of 0.76 was obtained for the instrument using KR- 20 formula. The research questions were answered using descriptive statistics of mean and standard deviation while the hypotheses were tested using analysis of co-variance (ANCOVA). The results revealed that there was a significant difference in the mean achievement score of secondary school students taught mathematics using cooperative learning method. The result also revealed a significant difference in the mean achievement score of male and female secondary school students taught mathematics using cooperative learning method in favour of male. The authors recommended, among others, that Mathematics Teachers should be encouraged to use cooperative learning method in teaching of mathematics to improve students' academic achievement in the subject.

Keywords: Cooperative Learning method, Achievement, Gender, Senior Secondary Schools.

Introduction

Mathematics as a science has ubiquitous influence on every disciplines and professions in Nigeria and the world at large. It is acclaimed to be the science of numbers and as such, it deals basically with figures, structures, order and relations. Stakeholders in education view mathematics as the bedrock of all science subjects and courses; as virtually all subjects involve calculations and uses mathematical concepts and skills. Aguele (2021) referred to mathematics as the science of space and numbers that has grown space and complexity including formal Arithmetic, Geometry, Statistics, Algebra, Trigonometry and Calculus. It is a core subject, from basic education to other levels of education due to the significant role it plays in science and technology which stands at the centre of modern development and economy. While science is the bedrock that provides the springboard for the growth of information and communication technology in modern day digital world, mathematics is the

gateway and key to the sciences as it is safely regarded as the “queen and servant of the sciences”.

Agbeboh (2024) observed that it is the mother of all sciences and the root to better understanding of everyday living. Therefore, creating a better understanding of its basic rudiments cannot be overemphasized. There are hardly any aspects of the sciences and technology that do not use mathematical concepts in the process of explaining its concepts and theories or models. However, mathematics can be said to enable learners to make scientific predictions that are drawn on the basis of logic and with the aid of mathematical methods, corrections, conclusions whose agreement, with reality, is confirmed by experience, experiment and practice. Strong mathematics skills exhibited by secondary school students are closely linked to their higher academic achievement in the subject. Their proficiency in mathematics is not only crucial for success in Science, Technology, Engineering and Mathematics fields but also enhances problem-solving, critical thinking, and analytical skills, which are transferable to other subjects and future careers. Conversely, it has been observed by researchers that difficulties in mathematics could negatively impact on the overall academic achievement of students and could also limit their future opportunities.

Students’ academic achievement in mathematics is the level of success a student demonstrates in mathematics learning measured through grades, standardized test scores and other educational indicators. It refers to the extent to which a student accomplished specific goals in mathematics within an educational context. Academic achievement in mathematics is a multifaceted construct that reflects a student's overall success in acquiring mathematical knowledge, skills and problem-solving abilities within an educational setting. Academic achievement of students could be poor or high depending on their grades or scores in examination. However, poor academic achievement of students over the years has been an overwhelming problem that researchers and educators all over the world have been sorting for a possible solution. This effect hinders students’ ability to excel in their academic endeavour towards the realization of learning objectives. No doubt, the teaching-learning process is challenged by the adoption of inappropriate learning methods. Most students in senior secondary schools in Nigeria in general and Edo State in particular are daily confronted with challenges of ill-motivated learning as a result of teaching method.

Many reasons have been attributed by researchers for students’ poor academic achievement in mathematics. Among these are poor teaching methods especially the conventional chalk, talk method or rote memorization and lack of proper knowledge of mathematics concepts to mention but a few (Ebhomien, 2017). According to him, teaching methods used in the classroom by the mathematics teachers are one of the root causes of the poor academic achievement of secondary school students in mathematics. The various teaching methods used by teachers at the Secondary Schools in the teaching of Mathematics include but not limited to demonstration method, lecture method, discovery, project, games, ethno-mathematics and laboratory methods.

Sa’ad and Usman (2024) emphasized that successful achievement of stated objectives in teaching and learning is always associated with using the right technique. It is for this reason that Literacy Basics (2023) insisted that for a learning method to be considered appropriate, such a learning method should be able to provide effective and productive learning by adapting to the learning styles and other needs of each learner, actively engaging learners in the learning process, helping learners become independent learners, supporting learners in reaching their objectives (plan items, sub-goals and goals), and prepare learners for transition to their goals. These qualities are inherent in cooperative learning method.

Cooperative learning method focuses on the use of authentic but pragmatic language as well as on asking students to do meaningful tasks using the target language (Wikipedia, 2019). It involves working together in small groups to accomplish shared goals or complete group tasks. It is widely recognized as a teaching method that promotes socialization and learning among students from pre-school through tertiary level and across different subjects and curriculum areas. Assessment is primarily based on the task outcome that emphasizes the appropriate completion of real world tasks

rather than accuracy of prescribed language forms.

Studies carried out by Austin (2003), Klain and Cavalier (2005), Pepple (2010) and Egwanwon (2024) revealed that cooperative learning method proved to be very effective in promoting learning and achievement in school. Cooperative learning methods may be informal groups that allow students to work together. They may be structured with students having specific tasks in their groups and assigned their group and individual performance. While cooperative learning groups generally involve four members, the number may be greater or fewer. Groups may work together for a few minutes, a couple of weeks or for many months (Slavin, 2001).

Cooperative learning method is a student centered method that offers alternatives to other learning methods. Frost (2017) posited that in a cooperative learning method, the teacher does not pre-determine what language and other related learning methods to be studied, instruction is based around the completion of a central task and it is determined by what happens as the students complete the task. In other words, rather than the students being receptive in their participation in the learning process in which they are expected to come under the authority of the teacher as an arbitrator of truth and the final evaluator of truth, cooperative learning method accords learners active participatory role in the learning process whereby teachers are considered as facilitators or guides.

Robertson (2019) reported that cooperative learning method is a viable and effective instructional methodology for teaching and learning mathematics. It helps to make mathematics exciting and enjoyable for both students and teachers. Cooperative strategies can be integrated at any grade level and for any mathematics topic. Students learn to cooperate with each other and to communicate in the language of mathematics. The classroom atmosphere tends to be relaxed and informal, help is readily available, questions are freely asked, answered and even shy students find it easy to be relaxed. Many students maintain a high level of interest in mathematics activities and have an opportunity to pursue the more challenging and creative aspects of mathematics.

When cooperative learning is deplored as a learning method, it usually refers to a learning method framework by students for the acquisition of secondary or universal body of knowledge which promotes active participation of students in the learning process in a collaborative arrangement. Cooperative learning method therefore, has root in the communicative language and participatory mode of teaching whereby the teaching process is done entirely through calculation tasks. In order to fully acquire mathematical dexterity, it must have real meaning by being used in natural contexts. Cooperative learning method demands that teachers assign purposeful tasks to students working as a team towards completion of such tasks which is expected to elicit the use of the target skills, language or formulae.

Cooperative learning method is also viewed as an instrumental strategy that simultaneously addresses academic and social skills learning by students. Cooperative learning is one way of providing students with a well defined framework from which to learn from each other. Students work towards fulfilling academic and social skill goals that are clearly stated. It is a learner approach where the success of the group depends upon everyone pulling his or her weight. Cooperative learning groups can be formal (long term structure); informal (short term, spontaneous); and base groups (long term and support oriented). While academic task is of primary importance, students also learn the importance of maintaining group health and harmony and respecting individual views.

In a recent study carried out to investigate the effects of cooperative learning method on students' achievement in Basic Science in Rivers State, Egwanwon (2024) found that there was a significant difference between students exposed to cooperative learning method and those taught with lecture method. From the empirical review on cooperative learning method and achievement above, it was obvious that cooperative learning enhances learning outcomes among students in basic science at secondary schools. Again, Sa'ad and Usman (2024) in a study on the impact of cooperative learning on secondary school students' academic performance in mathematics found that a significant difference exists in the mean score of students exposed to cooperative learning method and those exposed to

chalk and talk method. A gender difference was also observed in favour of the male when compared with the female students. Contrary, Obiefuna and Oruwari (2024) observed that the students exposed to conventional teaching method had a higher mean score compared to those exposed to other teaching method.

Adepoju, (2022) in a study to determine whether sex has any significant effect on the academic achievement of students in mathematics exposed to cooperative learning method observed that there was a significant difference in the achievement of male and female students exposed to cooperative learning method. The result showed that male performed higher than female students. Again, Obodo (2013) in a study on the effectiveness of cooperative learning strategy on students' academic performance in secondary schools in science observed that male performed better in science subjects than female students. Aigbomian (2012) in a study observed that gender does not play any significant interaction role in the academic achievement of male and female students in science and technology related areas.

Interview with teachers and students have shown that many students naturally develop phobia for mathematics. Even before they get admission into secondary schools, they seemingly have the notion that it is not easy to pass mathematics. Others opined that the method of teaching mathematics could be a possible reason for poor academic achievement in the subject. The question that agitates the mind of the researcher is: Is the traditional method of teaching mathematics having any effect on students' academic achievement? Is cooperative learning method having any effect on students' academic achievement in mathematics? It is the concerted efforts to provide answers to these questions that motivated the study.

Purpose of the study

The purpose of the study is to determine the effect of cooperative learning method on secondary school students' academic achievement in mathematics. Specifically, the study sought to determine:

1. the mean achievement score of secondary school students' taught mathematics using cooperative learning.
2. the mean achievement score of male and female students taught mathematics using cooperative learning method.
3. the interaction effect of teaching method and gender on students' academic achievement in mathematics.

Research Questions

The following research questions were raised to guide the study.

Research Question 1: What is the mean achievement score of secondary school students' taught mathematics using cooperative learning method?

Research Question 2: What is the mean achievement score of male and female secondary school students' taught mathematics using cooperative learning method?

Research Question 3: What is the interaction effect of teaching method and gender on students' academic achievement in mathematics?

Research Hypotheses

The following null hypotheses were formed and tested at a 0.05 level of significance:

Research Hypothesis 1: There is no significant difference in the mean achievement score of students' taught mathematics using cooperative and placebo learning method.

Research Hypothesis 2: There is no significant difference in the mean achievement score of male and female students' taught mathematics using cooperative learning method.

Research Hypothesis 3: There is no significant interaction effect between teaching methods and gender

on students' academic achievement in mathematics.

Methods

Research Design

This study employed a quasi experimental design (non- randomized, non – equivalent, pre – test, post – test, control group design). The choice of this design was considered appropriate when the true experimental design was not possible.

Population and Sampling Procedure

The sample consists of 288 (147 males and 141 females) senior secondary school students from four co- educational secondary schools. Two secondary schools each were assigned to both treatment and control group.

Research Instrument

The instrument for data collection was Mathematics Achievement Test (MAT) developed by the researcher. The MAT was made up of two sections. Section A elicited demographic information while section B consist of 40 well structured multiple choice questions from various topics in mathematics. The instructional packages were lesson plan prepared by the researcher based on cooperative learning method. The instrument was validated by experts in the field of mathematics education as well as measurement and evaluation.

Validation and Reliability of Research Instrument

A reliability index of 0.76 was obtained for the instruction. This was considered appropriate for the study. Both groups were pre – tested on their pre – knowledge of mathematics before the commencement of the experiment. The treatment group was later exposed to treatment package (cooperative learning method) for a period of four weeks while the control group was taught using the conventional method. Both groups were finally post tested using the MAT.

Data Collection and Analysis Procedures

The pre-test and post-test data were collected by the research assistant in the various schools used for the study. The research assistants were mathematics teachers trained by the researcher for the purpose of the study. Each of the research assistant had a minimum of first degree in mathematics education from a reputable university in Nigeria. The data collected was tested using ANCOVA.

Results

Answering Research Questions

Research Question 1: What is the mean achievement score of secondary school students' taught mathematics using cooperative learning method?

Table 1: Mean Achievement Score of Cooperative and Conventional Method.

Group	N	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	Mean Gain
Cooperative Method	160	37.25	6.90	70.26	8.68	33.01
Conventional Method	128	33.20	4.65	39.56	5.05	0.40
Mean Difference		4.02		30.70		33.41

Note. N = Population, SD = Standard Deviation.

Table 1 revealed that the post-test mean achievement scores of the cooperative learning method was 70.26 with standard deviation of 8.68, while that of the conventional method was 39.56 and

standard deviation of 5.05. The mean difference between the two groups for the pre-test and post-test were 4.02 and 30.70 respectively. The mean gain for the cooperative learning method was 33.01 and that of conventional method was 0.40. This showed that the mean gain of 33.41 between cooperative learning method and conventional method was in favour of the cooperative learning method (treatment group).

Research Question 2: What is the mean achievement score of male and female secondary school students' taught mathematics using cooperative learning method?

Table 2: Gender Mean Achievement Score in Mathematics Using Cooperative Method.

Group	N	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	Mean Gain
Male	147	30.50	5.05	73.65	8.25	43.15
Female	141	27.46	3.50	33.62	4.05	6.16
Mean Difference		3.04		40.03		49.31

Note. N = Population, SD = Standard Deviation.

Table 2 revealed that the post-test mean achievement scores of male students was 73.65 with standard deviation of 8.25, while that of female students was 33.62 and standard deviation of 4.05. The mean difference between the two groups for the pre-test and post-test were 3.04 and 40.03 respectively. The mean gain for the male students was 43.15 and that of female students was 6.16. This revealed that the mean gain of 49.31 between male and female students was in favour of the male students.

Research Question 3: What is the interaction effect of teaching method and gender on students' academic achievement in mathematics?

Table 3: Mean and SD of Interaction Effect.

	Treatment		Control		
Gender	Post-test Mean	Post- test SD	Post-test Mean	Post- test SD	Mean Gain
Male	73.65	8.25	42.25	3.56	31.40
Female	33.62	4.05	30.01	3.02	3.61
Mean Difference	40.03		12.24		35.01

Note. N = Population, SD = Standard Deviation.

Results in Table 3 revealed that the post-test mean achievement scores of male students was 73.65 with standard deviation of 8.25, while that of female students was 33.62 and standard deviation of 4.05 in the treatment group (cooperative learning method). The mean difference between the two groups for the post-test was 40.03. Again, the post-test mean achievement scores of male students was 42.25 with standard deviation of 3.56, while that of female students was 30.01 and standard deviation of 3.02 in the control group. The mean difference between the two groups for the post-test was 12.24. The mean gain for the male students was 31.40 while that of female students was 3.61. This showed that the mean gain of 35.01 between male and female students was in favour of the male students. Although the students in the treatment group obtained higher mean score than those in the control group, to determine whether these scores are statistically significant, it will be answered using the appropriate hypothesis.

Testing Research Hypotheses

Research Hypothesis 1: There is no significant difference in the mean achievement score of students'

taught mathematics using cooperative and placebo learning method.

Research Hypothesis 2: There is no significant difference in the mean achievement score of male and female students' taught mathematics using cooperative learning method.

Research Hypothesis 3: There is no significant interaction effect between teaching methods and gender on students' academic achievement in mathematics.

Table 4: Teaching Method and gender interaction

Sources of Variation	Sum of Squares	df	Mean Squares	F	Sig	Decision
Main effects	34967.133	2	11655.711	414.049	0.000	
Method	34498.477	1	34498.477	1225.500	0.000	Sig.
Gender	31.778	1	31.778	1.129	0.290	Sig.
2 way interactions	60.513	2	20.171	0.717	0.543	
Method & gender	11.799	1	11.799	0.419	0.518	NS
Explained	36125.230	4	4515.654	160.411	0.000	
Residual	4616.689	283	28.151			
Total	40741.919	287	236.872			

Note. df = Degree of Freedom, Sig. = Significance, NS = Not Significance.

Table 4 revealed F-calculated value of 1225.500 and F-critical value or significant value of 0.000 at 0.05 level of significance. From the table, it can be seen that F-calculated value of 1225.500 is greater than F-critical of 0.000 at 0.05 level of significance. Hence, the null hypothesis of no significant difference is hereby rejected. Therefore, there is a significant difference in the mean achievement score of secondary school students' taught mathematics using cooperative learning method.

Table 4 also revealed F-calculated value of 1.129 and F-critical value or significant value of 0.290. From the table, it can be seen that F-calculated value of 1.129 is greater than F-critical of 0.290 at 0.05 level of significance. Hence, the null hypothesis of no significant difference is hereby rejected. Therefore, there is a significant difference in the mean achievement score of male and female students' taught mathematics using cooperative learning method.

Table 4 of interaction effect further showed F-calculated value of 0.419 and F-critical value or significant value of 0.518. From the table, it can be seen that F-calculated value of 0.419 is less than F-critical of 0.518 at 0.05 level of significance. Hence, the null hypothesis of no significant interaction effect is hereby accepted. Therefore, there is no significant interaction effect between teaching methods and gender on students' academic achievement in mathematics. This means that the relationship between cooperative learning method and their impact on male and female students' academic achievement is simply additive which that the effect of cooperative learning method does not depend on the level or presence of male and female students' academic achievement in mathematics.

Discussion

Result of this study revealed that mean achievement scores of students taught mathematics using cooperative learning method differ significantly from the mean achievement scores of those taught using the conventional method and that there was a significant difference in favour of the treatment group. The finding was in agreement with Egwanwon (2024) who found that there was a significant difference between students exposed to cooperative learning method and those taught with lecture method. From the empirical review on cooperative learning method and achievement above, it was obvious that cooperative learning enhances learning outcomes among students in basic science at

secondary schools. Again, Sa'ad and Usman (2024) in a study on the impact of cooperative learning on secondary school students' academic performance in mathematics found that a significant difference exists in the mean score of students exposed to cooperative learning method and those exposed to chalk and talk method. This could be that, as students focus was on the concepts and techniques actually used by their cultural group rather than the possible mathematical theories available, they gained more knowledge. The idea of considering mathematics to be too abstract was also put away. By so doing the students' had greater understanding of the materials being learned. Their cultural interaction also helped the students to develop an instinctive kind of common mathematics knowledge that could be handed over to their next generation. In contrary, Obiefuna and Oruwari (2024) observed that the students exposed to conventional teaching method had a higher mean score compared to those exposed to other teaching method.

This study also revealed that the mean achievement scores of male and female students taught mathematics using cooperative learning method differ significantly in favour of the male students. The finding was in agreement with Adepoju, (2022) in a study to determine whether sex has any significant effect on the academic achievement of students in mathematics exposed to cooperative learning method observed that there was a significant difference in the achievement of male and female students exposed to cooperative learning method. The result also showed that male performed higher than female students. Again, Obodo (2013) in a study on the effectiveness of cooperative learning strategy on students' academic performance in secondary schools in science observed that male performed better in science subjects than female students. This could be that, as male students focus on the concepts and techniques actually used by their cultural group rather than the possible mathematical theories available, they possibly gained more knowledge when compared to the female students who will be involved in cooking and other domestic work associated with female folks. By so doing the male students' had greater understanding of the materials being learned. Their cultural interaction also helped the male students to develop an instinctive kind of common mathematics knowledge that could be handed over to their next generation when compared to their female counterparts. This study also revealed a no interaction effect between cooperative learning method and male and female students' academic achievement in mathematics. On the interaction effect, Aigbomian (2012) observed that gender did not play any significant interaction role in the academic achievement of male and female students in science and technology related areas.

Conclusion

The result revealed that cooperative learning method is more effective in teaching secondary school students' mathematics compared to the conventional method of teaching. So we can say that cooperative learning method create interactive learning environment for the learners to learn. It provides immediate feedback on the performance of the students. It also helps to maintain high interest level and sufficient motivation for the learners. Cooperative learning method have enriched features such as self-explanatory, self-directed, self- motivating and self- evaluating which help to cater for individual difficulties in mathematics.

Recommendations

Based on the findings of the study, the following recommendations were raised.

1. Mathematics teachers should be encouraged to use cooperative learning method in teaching of mathematics in secondary schools to improve students' achievement in the subject.
2. In-service trainings should be organized for mathematics teachers on the use of cooperation learning method in the teaching of male and female students in Edo State.

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