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Effect of Cooperative Teaching method on student Mathematics Achievement and Retention in Bayelsa State

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Abstract
This study investigated the effect of the cooperative teaching method on student retention in elementary statistics in mathematics in Ogbia Local Government Area of Bayelsa State. Two research questions and two null hypotheses guided the study. The study employed the pretest-posttest non-equivalent control group design using two secondary schools randomly selected and classified into experimental and control groups. Two intact classes of eighty-seven (87) Junior secondary school two (II) students from two secondary schools in Ogbia Local Government Area of Bayelsa State, Nigeria, were used. The instrument constructed by the researcher for the study is a Mathematics Achievement Test(MAT) validated by three mathematics educators. The reliability coefficient of 0.80 was obtained after the data collected from the test-retest was analyzed using Cronbach alpha. Data collected from the instrument (MAT) was analyzed using mean and standard deviation to answer the research question and t-test statistics were used to test the hypotheses at alpha level ≤ 0.05. The findings revealed that the cooperative teaching method increased students' retention in mathematics and thus improved students' achievement. Hence, it was recommended that the cooperative teaching method be applied by teachers in mathematics teaching.

Keywords: Cooperative teaching method, retention, mathematics, achievement, and statistics

Introduction

Many students believe that Mathematics is difficult to learn, which causes discomfort during and after mathematics lessons these difficulties are experienced when they are asked to recall some concepts from memory. Many researchers attributed it to reasons like the abstract nature of mathematics concepts (Luitel, 2019), strictness in teaching mathematics (Ali & Jameel, 2016), and the teaching methods employed by teachers (Oluwadayo, 2024; Yemi, 2019). Researchers such as Van (2023) have advocated for student-centred methods requiring teachers to involve students actively in teaching and learning which when applied will translate to effective and efficient teaching and higher grades for the learners. This is achievable because active involvement in the learning process helps learners remember activities carried out in the class or what the teacher said during the activity. Hence, active participation within and outside the classroom reinforces learned concepts and produces good achievement in all academic fields, including mathematics.

One of the student-active teaching methods proposed by Johnson and Johnson (2001) is the cooperative teaching method, defined as learning through cooperation or collaboration with others. The learners are often divided into small groups, teams, or units and are given topics to study and problems to solve. The students contribute to the team by sharing individual ideas in the group and then accepting a **s**ingle way to complete the given task and achieve a common goal. Many activities are performed by the individual student in the group such as observation, communication, and support. Mckeachies (2010) described a typical cooperative teaching method as a class where the teacher allows students to explain the concept being taught to each other to achieve expectations. The explanation from one student to another in the group helps for better understanding and enhances learning and mastery of the concept. The repeated explanation of the concepts helps in retaining knowledge of the concept. Oludipe et al. (2013) posit that in the cooperative teaching method when friendliness is established, students are motivated to learn and are more confident to ask questions from one another for a better understanding of the tasks being learned.

The teaching method used by teachers plays a powerful role in achievement pattern, subject combination, and choice of career; hence achievement has been the focus of some studies in cooperative learning. Altun (2015)

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investigated the effect of Cooperative Learning (CL) on Students' Achievement and Views on the Science and Technology Course, in a study group consisting of 7 girls and 13 boys, a total of 20 students from a private middle school in Istanbul. The results from the Altun study showed that the CL method positively impacted learning. Additionally, the cooperative learning-teaching environment fostered collaboration, promoted long-term retention, created opportunities for success, and contributed to the development of social and personal skills in the students as they are required to be successful at all learning stages. Gull and Shehzad (2015) researched the effect of Cooperative Learning on Students' academic achievement in the subject of Education and revealed that cooperative learning activities had a positive effect on the academic achievement of students enrolled in the subject of Education and recommended that teachers should use the cooperative teaching method in class**.** Barbara (2014) suggested that the foundation of cooperative teaching lies in valuing students, regardless of their ethnicity, intelligence, education, or social background, and believing in their ability to succeed academically. This method places significant emphasis on the careful structuring of learning groups. Various strategies can be employed, including fostering interdependence, creating interactive dynamics, and ensuring accountability. Moreover, developing essential social skills like decision-making, communication, and conflict resolution is crucial for the success of cooperative learning. From the review on cooperative learning, some advantages identified include the opportunity for students to recap the topics/concept at different stages, interaction among students at the maximum level, promotes peer learning as the group success is dependent on the success of the individuals, develop in the students a sense of self-esteem and self-efficacy which contributes to the emergence and development of students' social and affective skills.

For cooperative learning to be effective, students need a solid grasp of the material, strong teaching abilities to assist and correct their peers, good presentation skills to communicate the group's topic, and quick thinking which is also essential for success. The learning pyramid developed by Education Expert Edgar Dale in 1946 and later modified by National Training Laboratory Institute in the 1960s, suggested that most students only remember 10% of what they read from textbooks but retain nearly 90% of what they learn through teaching others. Mundey (2023) described the learning retention pyramid or cone of learning as a theoretical model that illustrates the various methods of learning and their expected percentage of retention in promoting long-term retention. In other words, teaching others is identified as the best way to retain knowledge known as retention. Balkkour (2012) described retention as preserving the after-effects of experience and learning that make recall or recognition possible. Likewise, Colman (2022) defined learning retention as the ability to store new information in one’s long-term memory so a person can easily recall it and put that knowledge to use in the future. If the information is not retained, it will remain in the short-term memory and drop out after a certain period. Hence, retention is the ability to give back ideas and knowledge learned previously, to bring forth, recall, or remember what has been said or taught. In the opinion of Johnson (2015), retention plays a significant role in determining the probability of a student dropping out of school and is an indicator of learning without which learners cannot apply knowledge to a new concept. Some benefits of learning retention include comprehensive understanding, skill development, long-term success, and increased motivation and self-confidence. Retention must be improved in the learners through strategies like active learning techniques, pre-assessment and goal setting, micro-learning, real-world context and application, continuous reinforcement, gamification, learning support and resources, regular knowledge checks, and follow-up opportunities.

Retention in mathematics is vital because mathematics concepts are hierarchical, which means that students build on already-known mathematical concepts to establish new or unknown concepts. Mathematics has been used by man before the commencement of the formal school system through direct interactions with physical objects in the environment, it has evolved from the use of symbols and elements for representation to a subject that is offered at all levels of education as an important and prerequisite for scientific and technological advancement of any nation therefore, the presentation of Mathematics concepts to students should be in a way that will make recalling of the concepts fast and easy to maximize the time, labour, and resources used in teaching. Mathematics helps to develop critical thinking, problem-solving, and reasoning skills in students. Reasoning skills are required by students to function effectively and efficiently in the real world in terms of career, self-development, and the nation's scientific and technological advancement. Therefore, this study aims to improve mathematics achievement and retention through cooperative teaching methods in junior secondary schools.

Research Questions

1. What are the mean achievement scores of students taught elementary statistics using the cooperative teaching method and those taught without the cooperative teaching method?

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2. What are the mean retention scores of students taught elementary statistics using the cooperative teaching method and those taught without the cooperative teaching method?

Hypotheses

1. There is no significant difference in the mean achievement scores of students taught elementary statistics using the cooperative teaching method and those taught without the cooperative teaching method.
2. There is no significant difference in the mean retention scores of students taught elementary statistics using the cooperative teaching method and those taught without the cooperative teaching method.

Methodology

The design of the study was a pretest-posttest non-equivalent control group design quasi-experimental. The population of the study was all the junior secondary two (II) students in Ogbia Local government area of Bayelsa State. A random sampling technique was used to select two (2) secondary schools for the study. One of the schools selected was assigned as the experimental group and the other as the control group using a ballot sampling technique. The students used for the study were eighty-seven (87) students from two intact classes in the selected schools. The researcher developed an instrument for data collection titled the Mathematics Achievement Tests (MAT) which consisted of 20 multiple test items covering topics in elementary statistics: methods of data collection, representation of data, mode, median, and mean with options A to D having three distractors and one correct option. MAT 1 served as a pretest to ascertain the entry level of the students; a reshuffled MAT1 served as a post-test (MAT2) administered in the fourth week of the experiment, and a reshuffled post-test (MAT3) served as a retention test administered two weeks after the MAT2 to ascertain the retention level of the students. Each correct item is two (2) marks, a maximum score of forty (40) marks, and a minimum score of zero (0) marks was obtainable.

The instrument face validation was done by three mathematics educators from the Federal University Otuoke, Bayelsa state, and the two mathematics teachers in the selected schools. The content validation of the test items was based on the test blueprint and the reliability coefficient of the test obtained was 0.72 using the Kuder Richardson KR-20 formula and the temporal stability coefficient index of 0.75 was obtained using the test-retest method. Permission letters to use students and mathematics teachers of the selected schools were written and sent to the principals who approved. Armed with the approval, the researcher met with the Junior secondary school two (2) mathematics teachers in the two selected schools on the first day and conducted training on using cooperative teaching methods in the teaching of mathematics. The two trained mathematics teachers thereafter served as research assistants. The week after the training and the first week of the experiment, the research assistants (mathematics Teachers) administered the pretest MAT 1 to the students in their classes, the scripts were scored and the marks obtained were analyzed to determine if the two groups had the same entry level. The analyzed data revealed that both groups have the same entry level. From the second week to the fourth week, the control group made of forty-five students was taught elementary statistics by their class teacher (the research assistant) without using the cooperative teaching method. The other research assistant in the experimental group divided the forty-two (42) students into six (6) units of seven (7) students each. The same topic and problems were given to the seven units in the experimental group and the students shared their ideas on how to solve the problems amongst themselves within the time allocated then the teacher summarized the lesson. The MAT 2 was given during the fourth week, whereas the MAT 3 (Retention Test) was conducted in the sixth week. MAT 2 & MAT 3 scripts were then scored and data was analyzed using the t-test. The computed mean and standard deviation for each of the groups (Control and Experimental) were used to answer the research questions, while the t-test was used to analyze the hypothesis.

Results

Research question 1: What is the difference in the mean achievement scores of students taught Mathematics with the cooperative teaching method and those taught without the cooperative teaching method?

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Table 1: The mean ($\bar{X}$) and standard deviation (S.D.) scores were compared between students taught Mathematics using the cooperative teaching method and those taught without it.

Groups	N	Pre-Test (MAT1)		Achievement Test (MAT2)		Mean Gain	Mean difference
		$(\bar{X})$	SD	$(\bar{X})$	SD		
Control	45	10.62	3.55	16.27	2.08	5.65	2.54
Experimental	42	9.95	3.01	18.14	3.01	8.19	

From Table 1, the data on students' achievement revealed that the students in the control group had 10.62 in the pretest (MAT 1) and 16.27 in the post-test (MAT2), while students in the experimental group had 9.95 in the pretest and 18.14 in the post-test. Control group students had a mean gain score of 5.65, and students in the experimental group had a mean gain score of 8.19. Therefore, students in the experimental group achieved slightly higher scores compared to those in the control group.

Research question 2: What is the difference in the mean retention scores of students taught Mathematics with the cooperative teaching method and those taught without the cooperative teaching method?

Table 2: Mean ($\bar{X}$) and Standard Deviation (S.D.) scores for students' retention in Mathematics (statistics), comparing those taught with the cooperative teaching method to those taught without it.

Groups	**N**	**Achievement Test**		**Retention Test**		**Mean Gain**	**Mean difference**
		$(\bar{X})$	**SD**	$(\bar{X})$	**SD**		
Control	45	16.27	2.08	20.21	3.94	5.94	4.83
Experimental	42	18.14	3.01	26.91	3.04	8.77	

From Table 2, the data on student retention revealed that students taught Mathematics with the cooperative teaching method had mean scores of 18.14 on the achievement test and 26.91 on the retention test while those taught Mathematics without the cooperative teaching method had mean scores of 16.27 on achievement test and 20.21in the retention test. Therefore, students taught with the cooperative teaching method had a mean retention gain score of 8.77 while those taught without the cooperative teaching method had a mean gain score of 3.91. Thou, there was an increase in student retention scores for both the control and the experimental groups; the increase in the experimental group was higher.

Research hypothesis 1: There is no significant difference between the mean achievement scores of students taught Mathematics (elementary statistics) with the cooperative teaching method and those taught without the cooperative teaching method.

Table 3: Mean score, standard deviation, and t-test of students taught statistics with the cooperative learning method.

Groups	**N**	**Mean**	**(S.D.)**	**t-Cal**	**t-Crit**	**df**	**p**
Experimental	42	18.14	3.01	2.24	1.99	85	0.05
Control	45	16.27	2.08				

In Table 3, the computed test statistic value is greater than the critical value (t-calculated = 2.24 > t-critical = 1.99); the researcher concluded that there is a significant difference between the mean achievement scores of students taught Mathematics (elementary statistics) with the cooperative teaching method and those taught without the cooperative teaching method. Therefore, the null hypothesis was rejected while the alternative hypothesis was upheld.

Research Hypothesis 2: There is no significant difference between the mean retention scores of students taught Mathematics (elementary statistics) with the cooperative teaching method and those taught without the cooperative teaching method.

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Table 4: Mean scores, standard deviation, and t-test of experimental and control groups.

Groups	N	Mean	(S.D.)	t-Cal	t-Crit	df	p
Experimental	42	26.91	3.64	4.32	1.99	85	0.05
Control	45	20.21	3.04				

In Table 4, the computed t-test calculated value exceeds the critical value therefore; the researcher concluded that there exists a significant mean difference in retention scores between the students taught Mathematics with the cooperative teaching method and those taught without the cooperative teaching method which is in favour of the experimental group.

Discussion

An insight into Table 1 revealed that students taught Mathematics using the cooperative teaching method achieved higher mean achievement scores than those taught without the cooperative teaching method. It is evident in the mean gain scores obtained that the cooperative teaching method provided an opportunity for the active involvement of students in the learning process. This result aligns with the result of Jebson (2012) on the impact of the cooperative learning approach on the achievement of secondary school students in mathematics using one hundred and twenty (120) senior secondary two (2) students from some selected secondary schools. The study revealed that the experimental group scored higher mean than the control group and recommended that mathematics teachers should work together to improve student achievement in mathematics. Likewise, Anijah (2023) on the influence of cooperative learning method on students' academic achievement in School Chemistry reported that a cooperative-based learning-teaching environment provided cooperation, supported permanent learning, provided opportunities to be successful, contributed to the development of social and personal skills of the learner. In particular, it enhanced students' level of creativity in expressing ideas as well as in grabbing new concepts and promotes a shared sense of community. The findings from Anijah's study in chemistry collaborate with the findings of this present study in mathematics that students' creativity skills and ability to learn new concepts are vital in mathematics learning.

Likewise in Table 2, students in the experimental group retained more of the concepts. The mean retention scores of students in the cooperative teaching method were higher compared to those taught without the cooperative learning method, this might be because the students explained the concepts in their simple language which aided their understanding and retention of concepts. This is in line with the findings of the research carried out by Chianson (2011) on the effect of the cooperative learning method compared with the conventional learning method to find out the retention level of students in circle geometry. The study was carried out on senior secondary II students in the three education zones (Zone A, Zone B, and Zone C) in Benue State, Nigeria. The study sample size was 358 senior secondary two (SSII) students. An independent T-test analysis was used to test the hypothesis while mean and standard deviation were used to answer the research questions. The findings of the study confirmed that students who were subjected to the cooperative learning strategy were able to retain more circle geometry concepts than those students who were taught using the conventional learning approach. Hence the recommendations were that students would be able to retain taught and learned concepts in mathematics for a longer time if mathematics teachers applied the cooperative learning strategy in teaching.

It was observed in Table 3 that there is a significant difference between those taught with the cooperative learning method and those taught without the cooperative learning method in favor of the experimental group. The t-calculated was higher than the t-critical which implies that the use of the cooperative learning method boasts the achievement of students in the experimental group. This is in support of some earlier work on cooperative learning methods such as Abdullahi, Adamu, and Sirajo (2023) study on the Efficacy of Cooperative Learning Strategy on the Mathematics Performance of Senior Secondary School Students in Sokoto State. A quasi-experimental design was adopted, which consists of two groups: the control group and the experimental group. Three objectives, three research questions, and corresponding null hypotheses guided the study. Two hundred and forty students (240) of intact classes from three schools chosen randomly served as sample for the study from all senior secondary school II (SSS II) students in Sokoto. The sample was divided into experimental and control groups. The instrument used for data collection was the "Mathematics Integration Performance Test" (MIPT), which consists of 24 items. The analysis showed that the t-critical is 1.98, the t-calculated is 2.02, and the P-value of 0.00251, which is less than 0.05 level of significance therefore the null hypothesis was rejected. Hence, there is a significant difference in the pre-test and post-test performance of secondary school students exposed to cooperative learning strategies in mathematics. It was then recommended

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that the cooperative learning method be adopted as one of the effective methods and pedagogy of mathematics instruction as the method helps students learn mathematics and improves their performance in school.

Jubril (2019) studied the impact of cooperative learning on senior secondary school students' mathematics achievement in Abuja, Nigeria. Two research questions and two research hypotheses guided the study. The study employed the pre-test, post-test experimental, and control group design. The sample consisted of 126 SS II students in two senior secondary schools in Abuja, Nigeria. The Mathematics Achievement Test (MAT) was used as the instrument. Data were analyzed using mean, standard deviation, and T-test statistics at a 0.05 level of significance. The result of the study revealed that there was a significant difference in the mean achievement scores of students taught mathematics using cooperative learning and those taught using the conventional method ($t=3.442$, $df=124$, $p<0.05$). Based on the findings and implications of the study, it was recommended that teachers should be encouraged to use cooperative learning methods of teaching in classrooms, this will improve students' achievement in mathematics. Table 4 showed that students taught with the cooperative learning method retained more of the concepts than those in the control group because the students were involved in brainstorming which increased their thinking ability and brought about improvement in retention of mathematical concepts.

This present study agrees with the research conducted by Isah and Hamza (2022) on the impact of cooperative learning strategy on performance and retention in geometry among junior secondary school students in Sokoto state, Nigeria. Four research questions and four null hypotheses guided the study. The design of the study was a quasi-experimental control group design such as a pretest, posttest, and post-posttest design. A purposive sampling procedure was used to select 354 students as a sample from the population of 10103 students. The Geometry Construction Performance Test (GCPT) was administered before and after the treatment. Independent t-test was used to analyze the hypothesis. The analysis of the data indicated that students taught with CLS performed and retained significantly higher than students taught with CLM. Based on these findings, the study concluded that CLS improved students' performance and retention in geometry construction of JSS III and recommends that CLS should be adopted in the teaching and learning of mathematics in general and geometry construction. The study conducted by Lekan and Emmanuel (2020), investigated the Effects of Cooperative and Individualized Learning Strategies on Students' Academic Retention in Mathematics in Minna Metropolis, Niger State. The design adopted for the study was a pretest, posttest, post-posttest quasi-experimental-control group design. The sample for this study consisted of One hundred and forty-seven (147) intact students chosen from three randomly selected senior secondary schools in Minna Metropolis, Niger State. A simple random sampling technique was used to select the three schools and three classes. The three (3) intact classes were assigned to experimental and control groups by balloting. Experimental groups one and two were exposed to cooperative and individualized learning strategies respectively while the control group (group three) was taught the same topics with the conventional method. Mathematics Achievement Test (MAT), 50-item objective questions were used to collect data for the pretest, posttest, and post-posttest. One research question was raised and one research hypothesis was formulated and tested in this study. The data were analyzed using Analysis of Covariance (ANCOVA). The hypothesis was tested at a 0.05 level of significance. The findings of the study revealed that students taught with cooperative learning strategies retained significantly better in mathematics than those taught with conventional methods.

Conclusion

In the conventional teaching approach, often referred to as the lecture method, the teacher delivers information to students through lectures, readings, or similar presentations. However, according to the learning pyramid, this method leads to only a 10% retention rate of the material presented. Relying solely on traditional methods for teaching mathematics is insufficient because it leaves students passive in the learning process. This study reviewed various research that incorporated cooperative learning strategies, and all indicated that these approaches are more effective than traditional methods. The findings demonstrated that cooperative learning is beneficial as it provides students with continuous guidance, support, and feedback from peers. It also fosters creativity by encouraging students to share ideas and understand new concepts, creating a collaborative and engaging learning environment. The study concludes that cooperative learning is an effective, innovative teaching strategy that enhances students' academic performance and retention in mathematics.

Recommendations

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

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1. Given the effectiveness of the Cooperative teaching method, teachers should be encouraged to use it in teaching mathematics at the secondary school level while a study could be conducted to find out its effectiveness at primary and tertiary levels of education.
2. Pre-service Mathematics teachers in various educational institutions should be taught how to use the cooperative teaching method while there should be in-service training and workshops for teachers on the cooperative teaching method.

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