Efficacy of Cooperative Learning Strategy on the Mathematics Performance of Senior Secondary School Students in Sokoto State

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Abstract

This study was carried out to find out the efficacy of the cooperative learning strategy on the mathematics performance of senior secondary school students in Sokoto State, Nigeria. A quasi-experimental design was adopted, which consists of two groups: the control group and the experimental group. Three objectives, three research questions, and their corresponding null hypotheses were precisely addressed in the study. Three schools were chosen at random for the study and its population, which includes all senior secondary school II (SSS II) students in Sokoto, 240 of whom were chosen through intact classes as samples from the three schools under study for both the experimental and control groups. The instrument used for data collection was the "Mathematics Integration Performance Test" (MIPT), which consists of 24 items and was validated by three (3) experts and has a reliability coefficient of 0.88. Based on the findings of the study, cooperative learning strategies have significant benefits for secondary school mathematics teaching and learning. It was then recommended that the cooperative learning strategy be adopted as the most effective method and pedagogy of mathematics instruction since the result of the study shows that cooperative learning helps students learn mathematics and improves their performance in school.

Keywords: Cooperative learning, Mathematics, Performance, Efficacy

Introduction

Mathematics is a discipline that studies numbers and how they are used. It involves calculations and solving problems. Mathematics is a fundamental part of human thought that provides an effective way of building mental discipline and encourages logical reasoning among learners, such can lead to the actualization of developmental aspects in economy, technology, science and national development (Park et al., 2021). Basically, the goal of mathematics education is to ensure that all students possess a suitable and sufficient mathematics background to become productive citizens in a society that is characterized by complex information and technology. On the part of some scholars, they revealed that there is considerable evidence indicating that the goals of mathematics instruction will be better achieved when cooperative learning procedures and strategies are employed. Students will be more cognitively active, more successful in problem solving, more confident in their basic general mathematics abilities, less anxious about learning basic general mathematics and further mathematics, more motivated to take mathematics courses, and better able to transfer what they know in mathematics concepts to real life situation and to develop their career. The lingering poor performance in mathematics is no longer a mere news item. Researchers such as Badru and Saka (2021) had previously warned the public about the poor standard of mathematics among Nigerian graduates from the primary, secondary, and tertiary levels of the educational system.

In the same vein, Mutange (2020) pointed out that poor performance in mathematics is a major problem in the Nigerian educational system and called for improved teaching and learning of mathematics in schools. Stressing the

ugly situation, the reports of the West African Senior Secondary Certificate Examinations (WASSCE) Chief Examiners (May/June 2019 and 2020) indicated that candidates' performance had been on a steady decline. This same alarm had been sounded by some studies, like those by Badru and Saka (2021) and Mutange (2020), who reported that many students fear and dislike solving problems in mathematics. Although mathematics is important and relevant to both the individual and the nation as a whole, secondary school students' achievement in maths is not encouraged, especially in West African Senior School Certificate Examination (WASSCE) and the National Examinations Council (NECO). The cause of students' poor performance in mathematics has not yet been fully identified in Nigeria, even though different efforts have been made by researchers, educators, the government, and non-governmental organizations. It has been suggested that various instructional strategies could improve students' performance in mathematics; for example, the National Mathematical Centre has provided a lot of teaching aids, strategies and much more to improve the teaching and learning of mathematics in all levels of education in Nigeria. In the sight of Khaleduzzaman (2020), error in mathematics is attributed to the lack of experienced and trained teachers who are not familiar with the modern methods and approaches to teaching the subject as appropriately as expected.

Cooperative strategy can be asserted as a kind of learning strategy in which students' study together and complete common goals. It can also be defined as small groups of learners working together as a team to solve a problem, complete a task, or accomplish a common goal (Isaac, et al. 2019). Cooperative learning is a teaching strategy whereby small groups of students, each with varying degrees of competence, employ a variety of educational activities to improve their understanding of a topic (Dyson & Casey, 2012). It denotes students functioning together to attain the objectives and the instructional event that organizes the students' joint effort. Cooperative learning begins with the formation of groups or teams of learners in the same grade and age bracket. The cooperative learning technique enables learners to learn from each other and gain important interpersonal skills (Topping, et al. 2011). In a cooperative learning environment, the goals of separate individuals become so linked that there is a positive correlation between them; on the contrary, in a competitive conventional environment, Since the students' objectives are so intertwined, there is an inverse relationship between their objectives and their accomplishments. Cooperative learning establishes a community in which students can get help and support from other group members immediately in a non-competitive learning environment by just raising their hands and waiting for the right answers to be given. The cooperative learning strategy can be used to learn most of the topics in the senior high school mathematics syllabus (Isaac, et al. 2019).

In recent years, many studies have been done on the topic of cooperative learning, grouping students, student academic achievement, and group rewards. The goals of cooperative learning are to enhance learners' learning and to develop their social skills like decision-making, conflict management, and communication skills. (Gull & Shehzad, 2015). In addition to this, the findings of Gull and Shehzad (2015) in their study titled "Effects of Cooperative Learning on Students' Academic Achievement" show that students who were exposed to the cooperative learning strategy performed better than those who were not involved in the cooperative learning strategy. This teaching strategy provides opportunities for higher-order thinking as opposed to passive listening, reinforces listening to others, and gives the opportunity for immediate feedback and adjustment of thought. Learners assist each other in understanding material or content, and this may even help them broaden their perspectives on issues. Often learners assess the ideas of peers, determining whether they disagree or partially agree, resulting in an opportunity for better formulating their own ideas. In cooperative learning, learners view each other as resources, not competitors, resulting in individual learning. Members often provide information prompts, cues, reminders, and encouragement in response to other learners' requests for help or their perceived need for help. This helps students develop their intellectual knowledge (Gull & Shehzad, 2015).

In the study conducted by Johnson, et al. (2017) on cooperative learning strategies returned to college, what evidence is there that it works? It stressed that cooperative learning is presently used in schools and universities in every part of the world, for students of all ages, and the findings show that students of cooperative learning strategies outperform their conventional methods groups in secondary schools and at higher levels. This is an effective teaching technique whereby small groups of students, each at varying degrees of skill, use a range of learning activities to

increase their understanding of the topic. Each team member is accountable for not only understanding the material being taught, but also for assisting teammates in doing the same, fostering a sense of accomplishment. According to the findings of a study conducted by Kaur and Kaur, (2021) in Punjab State senior schools on the cooperative learning strategy and performance in Mathematics in Relation to Problem Solving Ability, the performance in mathematics of the cooperative learning strategy group was significantly higher than that of the conventional teaching strategy group. In another related development in the study titled Impact of Cooperative Learning Approach on Senior Secondary School Students Performance in Mathematics, asserts that there is no significant effect between male and female students performance in mathematics using cooperative learning approach. The study adopted quasi-experimental design and uses t-test statistics as data Analysis Avenue, the result shows that t-critical is found to significantly greater than t-calculated and that leads to the rejection of the null hypothesis. Similarly, Ajaja and Eravwoke (2018) investigated the Effects of Cooperative Learning Strategy on Junior Secondary School Students Achievement in Integrated Science. Their major finding revealed significantly higher achievement test scores for students in cooperative learning groups than for those in traditional classrooms. Thus, based on their findings, instruction in cooperative strategies could have permitted the low-achieving students to gain control of their learning activities and, therefore, be able to learn the processes in science subjects such as labelling, drawing, identifying, and some concepts in sciences.

In order to look into the theoretical aspect of this research paper, it is important to consider the contribution of Kolb, (1984), who proposed that the experiential learning theory maintains that learning is the process by which knowledge is formed via the transformation of experience. Kolb's 1984 model was chosen to demonstrate alternative approaches to critical thinking in role play and career development planning because it is widely utilized by teachers and health care practitioners (Rolfe, 2011). In 1984, Kolb created the experiential learning cycle, which consists of four stages. Kolb combined goal-directed and behaviour-based learning theories to produce a learning cycle that values process and the continuous aspect of learning (Kolb, 1984). In accordance with the experiential learning of Kolb (1984), as cited in McLeod (2013, p. 38), there are four stages to the experiential learning cycle: concrete experience, reflective observation, abstract conceptualization, and active experimentation. However, Kolb's reflective model of the cycle of experiential learning, which is made up of some career development planning as a flight attendant, is presented in Fig. 1 under the model's four stages. Brief explanations of each of these stages, as in McLeod (2013, p. 39), are as follows:

i. The Concrete Experience: The first stage of Kolb's model describes the actual event that will take place. Kolb emphasizes the importance of the reflection component in the learning cycle. This stage allows students to reflect on what has just occurred during the experience.
ii. The Reflective Observation: The second stage of Kolb's model connects past knowledge and experiences to career goals. A student recounts and evaluates their experiences at this stage. Students gather information for other locations on the model at this stage. Following the completion of the goal, the student asks herself specific questions such as, "What has worked well?" What hasn't been working? How do I account for my success or failure thus far? What factors have contributed to the experience?
iii. Abstract conceptualization: The third stage of Kolb's model allows the student to consult literature and discuss with colleagues who share his or her viewpoint; at this stage, the student modifies his or her thinking and reassesses the situation. Students explicitly link their experiences to their prior learning, their expectations, and the experience's outcome. Furthermore, the student experiments with various techniques for dealing with the situations.
iv. Active Experimentation: The fourth and final stage of Kolb's model allows students to try out new approaches, theories, or solutions in the same or different situations. This provides students with more experience on which to reflect in the future. As the student analyses her experience at this point, she develops a plan for how things will be done differently in the future. She may be able to put her modern approaches, theories, or solutions to the test in a relevant context. The student uses reflection to plan for future learning opportunities. She puts her newly acquired theoretical knowledge into practice by bringing her ideas, reviews, and suggestions for improvements back into her practice to try out new strategies.

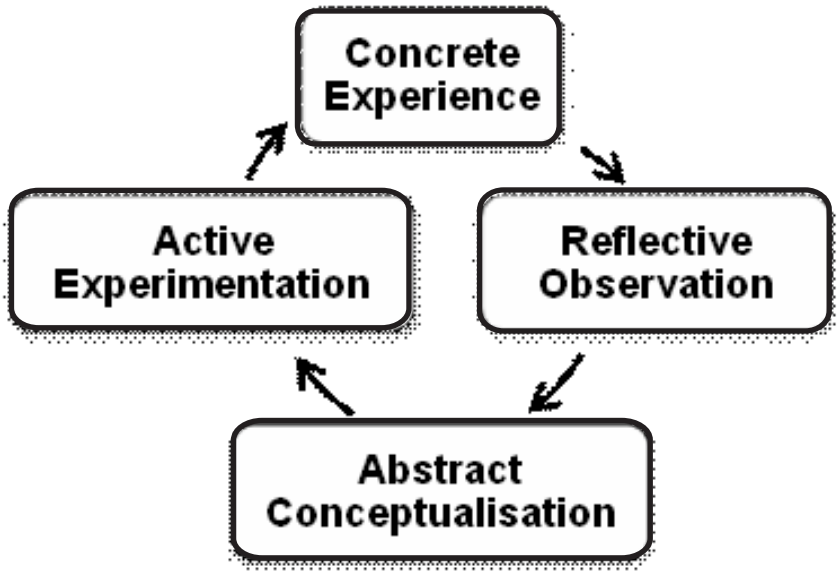

Fig 1: The Cycle of Experiential Learning in Kolb's Reflective Model (1984)

In summary form with regards to the illustrations in the model, the boxes may be used to analyse and reflect on a situation, habit, mode of practice, or service delivery. The models can be used for expedience or more profound reflections at different times. Both feature the need to consult the literature and discuss the situation with others, such as colleagues, service users, managers, or family and friends. The model enables the development of reflection. The status of mathematics in the Nigerian educational system is in jeopardy due to a number of factors. This is due to the poor performance and negative attitudes of both teachers and students in today's classrooms. Considering the ongoing need for arithmetic proficiency in today's society, the quality of mathematics education is unquestionably insufficient. Even though both primary and secondary school students need to learn the fundamentals of mathematics, many do not yet understand them at the level needed (Evans & Field, 2020). Stakeholders in the education sector in Nigeria have a complaint regarding the tactics used in the teaching of mathematics at various levels of education. Learning mathematics in certain programs entails employing a variety of methodologies, approaches, tactics, and procedures with the use of appropriate instructional resources. Some approaches used by some mathematics teachers are tedious, uninteresting, difficult, and pointless from the learner's perspective. It is also believed that mathematics is an extraordinarily hard subject that takes extraordinary talent and ability to study.

However, no one should be burdened with the study of this complicated issue. Several authors, academics, and educators have looked into a variety of issues as one or more of the causes of students' poor academic performance in mathematics. As reported by the West African Examination Council (WAEC) in 2016, 2017, 2018, 2019, and 2020, as displayed by the National Bureau of Statistics (2021), the percentages of public secondary school students from Sokoto State who sat for the final examination and scored 5 credits or above, including mathematics and English, are 29.5%, 38.92%, 34.03%, 50.2%, and 43.7%, respectively. Due to the non-participation of Sokoto public secondary school students in WAEC in 2021 and 2022, the state is excluded from the 2021 and 2022 WAEC reports. However, with these outcomes, it is discouraging that none of these attempts have resulted in a beneficial outcome by reversing this dreadful trend. The study of increasing senior secondary school students' academic performance in mathematics using collaborative learning strategies is a worthy endeavor. It may be agreed that an innovative teaching and learning technique will result in students having a better comprehension of mathematical concepts during the teaching and learning process, which will considerably minimise the problems associated with poor mathematics performance. With these issues as impediments, this study attempts to determine the efficacy of cooperative learning strategies on students' academic performance in mathematics in secondary schools in Sokoto State.

Purpose of the Study

1. To find out the difference in the performance of students taught mathematics using a cooperative learning strategy and those taught using conventional methods.

2. To determine the effect of gender on the performance of senior secondary school students who were taught using a cooperative learning strategy.
3. To determine the difference in pre-test and post-test performance of secondary school students exposed to cooperative learning strategy.

Research Questions

a) What is the difference in the performance of students who were taught using cooperative learning strategy and those taught using conventional methods?

b) What is the effect of the performance of senior secondary school students who were taught mathematics using the cooperative learning strategy?

c) What is the difference in the pre-test and post-test performance of secondary school students exposed to cooperative learning strategy?

Research Hypotheses

1. There is no significant difference in the performance of students who were taught using cooperative learning strategy and those taught using conventional methods.
2. There is no significant effect of the performance of senior secondary school students who were taught mathematics using the cooperative learning strategy.
3. There is no significant difference in pre-test and post-test performance of secondary school students exposed to cooperative strategy.

Methodology

This study employed a quasi-experimental design, which consists of two groups: the control group and the experimental group, as illustrated in Fig. 2. The experimental group adopted the cooperative learning strategy, while the control group was taught with the conventional method. A pre-test and post-test were also administered to both the control group and experimental group using the Mathematics Integration Performance Test (MIPT).

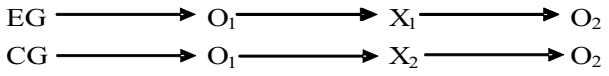

Fig 2. Research Design Illustration

Three schools were randomly selected; among these schools, there was one mixed school, one boys' school, and one girls' school for this study. The population of the study consists of all senior secondary school II (SSS II) students in the study area. The school samples for this study were randomly selected, and the sample size of 240 students was obtained through intact classes for the experimental and control groups from the sampled schools. The instrument used in this study was the Mathematics Integration Performance Test (MIPT). This instrument consists of 24 question items constructed to cover all the topics treated during the experimental and conventional teaching periods. These items were constructed to test for the understanding of the mathematical concepts and, at the same time, the application of what has been learned. Three (3) experts validated the face and content of the MIPT: two from senior secondary schools outside the sampled schools and one from UsmanuDanfodiyoUniversity Sokoto, department of Science and Vocational Education. A reliability coefficient of 0.88 was obtained with the aid of Kuder Richardson (KR-20). The selected samples of students were divided into two groups. Group 1 served as the control group (CG) and was taught using the conventional lesson method, while group 2 served as the experimental group (EG) and was exposed to cooperative learning strategies. For four (4) weeks, the two groups were taught. The same test items were administered to both groups by the researchers, and at the end, their scores were collected and analysed using t-test statistics.

Results

Table 1: Summary of analysis of the difference in the performance of students in experimental group and control group

Groups	Mean	SD	N	Df	Std Error	t-crit	t-calc
Cooperative learningstrategy	41.91	15.37	120	118	1.40	1.98	3.13
Conventional methods	36.60	19.26	120				

The computed means for the cooperative learning strategy and conventional methods are shown in Table 1 as 41.91 and 36.60, respectively. Additionally, cooperative learning strategies and conventional methods, respectively, obtained standard deviations of 15.37 and 19.26. The critical t-value was 1.98, and the calculated t-value was 3.13. At 118 degrees of freedom and a 0.05 level of significance, the estimated t-value, 3.13, was found to be higher than the critical t-value, 1.98. According to the findings, hypothesis 1, which claims that cooperative learning strategies and conventional methods of teaching have no significant difference in students' performance in mathematics, is therefore rejected. As a result, the cooperative learning strategy outperforms conventional methods of teaching mathematics at the senior secondary school level in terms of student performance. Thus, cooperative learning strategies need to be incorporated into our daily mathematics teaching in order to uplift the understanding of mathematics among students at the senior secondary level of education.

Table 2: **Summary of analysis of students' scores in the experimental group and control group based on gender .**

Groups	Mean	Standard Deviation	N	Df	Standard error	t-critical	t-cal.	P-value
Male	45.80	22.54	60	58	2.05	1.98	1.69	0.02623
Female	41.30	18.85	60					

P<0.05

The mean and standard deviations, computed t-value, and critical t-value are shown in Table 2. The average scores for the male and female students who were taught using a cooperative learning strategy were 45.80 and 41.30, respectively. For the male and female students, the respective standard deviations were 22.54 and 18.85. The t-critical value is 1.98, and the calculated t-value is 1.69. At 58 degrees of freedom and a 0.05 level of significance, it was found that the t-calculated value (1.69) was less than the t-critical value (1.98); this shows that there are no significant differences in the mathematics performance of male and female students when using a cooperative learning strategy in the teaching and learning of mathematics in secondary schools. This has strongly indicated that gender sensitivity should be taken into account when it comes to learning mathematics without discrimination. Every student should have an equal chance of participating in class activities.

Table 3: Shows the summary of analysis of the scores of pre-test and post-test performance of secondary school students exposed to cooperative learning strategy.

Groups	Mean	SD	N	Df	Std error	t-tcrit.	t-cal.	P-value
Pre-test	35.31	13.37	120	118	1.66	1.98	2.57	0.00251
Post-test	38.62	11.26	120					

As in Table 3, it is clearly indicated that the mean and standard deviation of the pre-test are 35.31 and 13.37, respectively, and the mean and standard deviation of the post-test scores are 38.62 and 11.26, respectively, at 118 degrees of freedom. The t-critical is found to be 1.98, the t-calculated to be 2.02, and the P-value is 0.00251, which is less than 0.05 level of significance. This indicated that the null hypothesis has to be rejected, and the interpretation of hypothesis three vividly says that there is a significant difference in the pre-test and post-test performance of secondary school students exposed to cooperative learning strategies in mathematics.

Discussion of Findings

In line with the results of the tested hypothesis in Table 1, it is clear that cooperative learning strategies have significant benefits for secondary school mathematics teaching and learning. In terms of student performance, students in a cooperative learning strategy outperform students in a conventional methods group of teaching mathematics at the senior secondary school level. The finding is in line with the study conducted by Johnson et al. (2017), which asserts that students who use cooperative learning strategies outperform their conventional method groups in secondary schools and at higher levels. It means that how students interact with one another should not be overlooked as an aspect of instruction and that it can improve students' attitudes toward mathematics by providing social interaction, which boosts confidence and a positive attitude toward mathematics. This finding is also similar to the findings of Ajaja and Eravwoke (2018) who investigated the Effects of Cooperative Learning Strategy on Junior Secondary School Students Achievement in Integrated Science. Their key conclusion was that children in cooperative learning groups performed much better on achievement tests than those in conventional classes. With reference to the second hypothesis tested in table 2, it is clearly indicated that there are no significant differences in the mathematics performance of male and female students when using a cooperative learning strategy in the teaching and learning of mathematics in secondary schools. This has strongly indicated that gender sensitivity should be taken into account when it comes to learning mathematics without discrimination. Every student should have an equal chance of participating in class activities, regardless of their status. This is in line with the findings of Sofeme, (2012) in the study titled "Impact of Cooperative Learning Approach on Senior Secondary School Students Performance in Mathematics" which shows that there is no significant effect between male and female students' performance in mathematics using cooperative learning approach.

With regards to the analysis output of hypothesis 3 in Table 3, it shows that the mean and standard deviation for the scores of students in both the pre-test and post-test output indicated that there were differences in the students' performance in mathematics. This indicated that students who were engaged in cooperative learning strategies had highly outstanding performance compared to when they were not engaged in the treatment process. The post-test performance of students in mathematics has overshadowed their performance in the pre-test. This finding is in agreement with the findings of Gull and Shehzad (2015), which show that students who were exposed to the cooperative learning strategy performed better than those who were not involved in the cooperative learning strategy. This is an indication of the importance attached to the use of cooperative learning strategies in the teaching and learning of mathematics in order to give learners a free chance to exercise their critical thinking about the problems in mathematics whenever the need arises. The entry behaviour and knowledge of students have exponentially improved due to their engagement in cooperative learning strategies.

Conclusion

The study is based on the efficacy of cooperative learning strategies on the mathematics performance of senior secondary students in Sokoto State. Because mathematics is a vast subject with many methods for teaching and learning, it may take more than one method to overcome or solve some problems, whether complex or simple in nature. That is why the researcher tried to see whether or not the cooperative learning strategy could be effectively used in the teaching and learning of mathematics in order to improve students' performance in mathematics side-by-side with the traditional or conventional methods used in the process of mathematics teaching and learning. The teacher must provide general oversight while also encouraging the student-helping-student procedure. Going by the findings of this study, a cooperative learning strategy should be adopted as a mode of instruction to replace the conventional method that dominates our secondary schools. This is due to the fact that a cooperative learning strategy has significantly improved the performance of students in mathematics, as shown in this study; therefore, it is good to encourage the cooperative learning strategy in learning mathematics in conjunction with another learning strategy for greater efficacy, especially

in the teaching and learning of mathematics at senior secondary school levels.

Recommendations

The subsequent recommendations were made in light of the study's findings:

1. Cooperative learning strategy should be adopted as mode of instruction, since the result of the study shows that cooperative learning helps students in learning mathematics and improves their performance in schools.
2. The Federal and State Ministries of Education and other educational bodies like the Nigeria Educational Research and Development Council (NERDC) and the Science Teachers Association of Nigeria (STAN) should organise training and workshops for mathematics teachers. They might do this to refresh their knowledge of how cooperative learning is used in Nigerian schools to enhance instruction and learning.
3. The school curriculum should offer possibilities for bringing out the learner's intrinsic qualities as such 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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