Effect of Reciprocal Cooperative Learning Strategy on Senior Secondary School Students' Academic Performance in Mathematics in Taraba State, Nigeria

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Abstract

This study investigated the Effect of Reciprocal Cooperative Learning Strategy on Secondary School Students' Academic Performance in Mathematics in Taraba State, Nigeria. The research was guided by two objectives, two research questions and two hypotheses, using a quasi-experimental research design. The area of study was in Taraba state. The population comprised 96,170 Senior Secondary School Students' in Taraba State (55,027 males and 41,143 females). A sample of 172 SSS II students were sampled using simple random sampling techniques. The classes were assigned to experimental and control groups using simple random sampling techniques. Eighty-three (83) were assigned to Experimental group out of which (42 males and 41 females) and Eighty-nine (89) were assigned to Control group out of which (44 males and 45 females) using simple random sampling techniques. The instrument used for data collection was the Students' Mathematics Performance Test (SMPT). The instrument was validated by four experts one secondary school teacher from Girei, and one from physical science education department of the Modibo Adama University, Yola and two from mathematics department of the Modibo Adama University,Yola. The student mathematics performance test items were subjected to trial testing to ascertain the reliability of the instrument using Kuder Richardson-21, the reliability coefficient of 0.87 was obtained. Data were analyzed using descriptive statistics of mean and standard deviation to analyze the research questions, and Analysis of Covariance (ANCOVA) was used to test the null hypotheses at 0.05 level of significance. The findings of the study revealed that there was significant difference in the mean academic performance scores of students taught mathematics using Reciprocal cooperative learning strategy and those taught using conventional method $F(1,169 = 84.539; P < 0.05)$. In favour of Reciprocal Cooperative Learning Strategy. However, the finding revealed that there was no significant mean difference in the performance scores of male and female students taught mathematics using Reciprocal cooperative learning strategy $F(1,80 = 0.063; P > 0.05)$. Based on the findings of this study, it was recommended that teacher should be encouraged to adopt Reciprocal learning strategy in teaching and learning of mathematics, and government should also embark on training of mathematics teachers on how to use Reciprocal Cooperative learning strategy as mode of teaching to ensure high performance of students irrespective of gender.

Keywords: Academic Performance, Gender, Reciprocal Learning Strategy

Introduction

Mathematics, often hailed as the universal language, is the foundation of countless scientific discoveries and technological advancements. It allows us to comprehend the fundamental principles that govern our world. Mathematics is a gateway discipline to other fields such as science, technology and engineering (Li & Schoenfeld, 2019). Mathematics is an important subject due to its utility to the development of the world. It is taught at all levels, and it is a compulsory requirement for admission into tertiary institutions in Nigeria (Joint Admission & Matriculation Board, 2016). Mathematics is a very desirable tool in all spheres of human endeavor, such as science, engineering, social science and arts. It is the bedrock on which the technological development of any nation is hinged (Oloda, 2021). According to Adetula cited in Oloda (2021), Mathematics is a vital task in national capacity building in science and technology and therefore, any short coming in the subject constitutes drawback to the achievement of science and technology aims. The Federal Republic of Nigeria (2013) stipulated in her National Policy on Education, as one of the core subjects that will enable an individual to gain admission into higher institution, thereby making it a course that holds the key for further academic progress. To have the chance to study any discipline in the university, polytechnic or colleges of education, an individual must have obtained a credit pass in mathematics in West African Senior Secondary Certificate Examination or its equivalent.

The impression that the learning of Mathematics is exclusively reserved for science students. The truth remains that the need for the learning of Mathematics has now gone beyond Mathematics for only school students. Mathematics is for life, hence it cuts across every sphere of life, given the level of sophistry in digitalization, scientific and technological advancements as the predominant trend in our society. In Nigeria, despite the fact that the government has clearly confirmed the importance of mathematics by making it compulsory subject at both junior and senior secondary levels (Rajmonda & Eda, 2021), invested billions of Naira in the teaching and learning of mathematics. Therefore, any short coming in this subject mathematics can bring setback to the achievement of science and technology objectives. In view of this, researchers recommended various methods that are applicable in teaching and learning of mathematics, but research evidences revealed that many teachers used traditional method of teaching which may be the causes for students' poor academic performance in the subject (Ginga, Mohammed & Usman 2019).

Academic performance refers to the scholastic stand of a student at a given time. Adeyemi (2018) viewed academic performance as the quality of result produced by student as reflected in the quality of their examination score. Adeyemi (2018) viewed academic performance really involved how much students have learned. In mathematics, students performed poorly in schools over many years. Research evidences revealed that poor performance of students in mathematics is attributed to insufficient teaching materials, mathematics phobia, teaching method, poor teaching facilities that includes equipment and instructional materials for effective teaching. In this study academic performance refers to the extent to which a student,

teacher, institution or system has achieved specific educational goals and objectives. It is commonly measured through assessments, grades and other indicators of learning outcomes. This concept is the key in education as it reflects the effectiveness of both teaching and learning processes (Alemu 2020). Students' academic performance is the extent to which a student has achieved in his/her educational goals for the period of the study as indicated by the student's cumulative grade point. Although according to Shofiyyah, Komarudin and Juita (2023), academic performance is commonly measured through examinations or continuous assessments but there is no general agreement on how it is best evaluated or which aspects are most important procedural knowledge such as skills or declarative knowledge such as facts. Also there is a consistent below average performance of students in mathematics in Taraba State. In the year 2020, 31% failed, while in the year 2021 reporting 5.16% failed. In the year 2022, 21.75% failed. In the year 2023, 15% failed. In the year 2024, 32.60% failed, Taraba State Ministry of Education (2024), was not encouraging. Poor performance in mathematics is a major impediment to the educational attainment and advancement of students in Taraba State, Nigeria. The West African Examination Council (WAEC) gave the percentage failure in mathematics in Taraba State, Nigeria. This gives an average percentage failure rate of 20.4% in mathematics from (2020-2024). If this failure trend is not checked, Taraba State will continue to lag behind with respect to filling her quota in science and technology related courses in tertiary institutions in Nigeria. This has generated a great concern among teachers and other stake holders because poor academic performance of students has been attributed partly to be caused by teachers' incompetency and inappropriate use of teaching strategy among other factors which will lead to pursue science related courses in tertiary institution. It is believed that some teaching methods and strategies especially those that are learner centered such as reciprocal cooperative learning can be used by teachers to improve students' academic performance. Failure in mathematics can lead to difficulties in accessing higher education, as well as employment opportunities for both gender in mathematics.

Gender is concerned with the sex of students which can either be male or female. Gender has remained a subject of argument and relevant in education, especially in mathematics, because it has been linked to performance and participation in certain career. Gender refers to socially constructed roles and relationships, personality traits, attitudes, behaviors, values, relative power and influence that society ascribes to sexes on a differential basis (Singh 2014). The term gender refers to a wide range of biological, behavioral, physical and mental characteristics regarding to and differentiating the female and the male population (Singh 2014). Therefore, gender is a critical issue which has attracted the attention of mathematics teachers especially due to the fact that gender equality is a focus in all sectors of life. The gender of a student can be a fundamental variable in explaining academic performance of learners. One of the intriguing explanations on variation in gender on achievement of students academically relates with the dynamics of gender interaction between the student and the teacher, especially to gender combination of

students and teachers. Filgonali and Sababa (2017) noted that, treatment of male and female students should be treated equally during teaching and learning and all students should be provided with the opportunities and engagement irrespective of gender. Therefore, to provide equal chances to learning, teachers must avoid biasness in the way different gender are handled academically and in particular interaction with learning materials, teachers and classmates. Therefore, this study is an attempt to see if Reciprocal Cooperative Learning Strategy can be used to address poor students' academic performance in mathematics.

Reciprocal teaching for mathematics strategy is based on the model proposed by Palincsar and Brown (1984), but has a number of key adjustments with solving instead of questioning. Therefore, before Reciprocal can be successful by students, they need to comprehend the below strategies; At first, students are group into four per group. Distribute one note card to each member of the group identifying each person's unique role. Students have to read the questions given, the teacher has to encouraged them to use note-taking strategies such as selective underlining or sticky-note prepare for their role in the discussion. The predictor is required to predict the type of mathematical questions they are being asked, what type of mathematical operations they may be required to use. The clarifier will address words that are unfamiliar with, and state all the facts they know. The students are required to solve the problem using a number of problem-solving options. The summarizer is required to justify their answer and evaluate how they would refine the process if presented with a similar problem (Segerby and Chronaki 2018). To prove that application of Reciprocal Learning strategy in mathematics Ginga, Mohammed and Usman (2019) conducted research on effect of Reciprocal Teaching Strategy on students' academic performance in word problem leading to simultaneous equations for creativity in basic secondary and tertiary education and the findings shows it enhanced students' academic performance.

Statement of the problem

The academic performance of students in mathematics, particularly in Taraba State, Nigeria, has consistently been below expectations. This persistent underperformance poses a significant challenge, as mathematics is not only a core subject but also a gateway to fields such as science, technology, and engineering, which are crucial for national development. The low retention of mathematical concepts among students further exacerbates the problem, as many students struggle to apply mathematical principles in subsequent studies or real-world situations in external examinations in Mathematics in Taraba State, Nigeria. Data from the West African Senior School Certificate Examination (WASSCE) conducted by the West African Examinations Council (WAEC, 2024) highlight this trend, as indicated in Appendix I.

Despite all efforts by teachers, stake holders and parents to students' in improving their academic performance in mathematics prove abortive via extra-moral lessons and tutorials the performance remains inconsistent and point to a persistent challenge in mathematics. Various factors contribute to this problem, including ineffective instructional methods, lack of student engagement, poor classroom interactions and

limited opportunities for cooperative learning. In response to these challenges, educational researchers and practitioners have proposed the use of innovative teaching and learning strategies that actively engage students in the learning process. One such strategy is the reciprocal cooperative learning strategy which is grounded in social constructivist theory, which emphasizes learning through interaction, dialogue and shared responsibility.

Objectives of the study

This study has the following specific objectives:

1. To determine the effect of reciprocal cooperative learning strategy and conventional method on the academic performance of senior secondary school students in mathematics in Taraba State, Nigeria.
2. To determine the effect of reciprocal cooperative learning strategy on the pretest and posttest male and female academic performance in mathematics in Taraba State, Nigeria.

Research Questions

To ensure the attainment of the slated objectives, the following research questions are raised to guide the study;

1. What are the pretest and posttest mean academic performance difference scores of senior secondary school students taught mathematics using reciprocal cooperative learning strategy and those taught using conventional method?
2. What are the pretest and posttest mean academic performance difference scores between male and female secondary school students taught mathematics using reciprocal cooperative learning strategy?

Null Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significant.

$H0_1$: There is no significant difference between pretest and posttest mean academic performance scores of senior secondary school students taught mathematics using reciprocal cooperative learning strategy and those taught using conventional method.

$H0_2$: There is no significant difference between pretest and posttest mean academic performance scores of male and female senior secondary school students taught mathematics using reciprocal cooperative learning strategy.

Methodology

The design adopted for this study was quasi-experimental, a Pre-test, Post-test, nonequivalent, non-randomized control group design. The area of the study was in Taraba State, Nigeria. The population of the study was 96,170 (consists of 55,027 males and 41143 females) SSS II mathematics students of Taraba State public secondary schools. There are nine (9) education zones in Taraba State. One (1) education zone was selected which was Zing Education Zone, using simple random sampling technique. Out of the one (1) zone selected (Zing Zone), four schools were selected from the zone, using simple random sampling technique making the total of four (4) public secondary schools within Zing Zone. Out of the four (4) secondary schools that was selected two (2) secondary schools were assigned to experimental group and two (2) secondary schools were assigned to control group using simple random sampling technique. A total number of one hundred and seventy-two (172) SSS II students were sampled. Eighty-three (83) were assigned to experimental group out of which (male 42 and female 41) and Eighty-nine (89) were assigned to control group out of which (male 44 and female 45). The instruments for data collection was the Students Mathematics Performance Test (SMPT). To ensure content validity, the adapted instrument was validated by two experts in mathematics department from Modibo Adama University Yola, one expert in physical science education department from Modibo Adama University Yola, and one secondary school teacher from Government Day Secondary School (GDSS Girei) making a total of four validators. The items were reviewed for relevance, clarity, coverage of content and appropriateness for the students' level. Based on their feedback, necessary modifications were made. The revised instruments were pilot tested on a sample of 20 students from a different school outside the study. KR-21 method was used to determine the reliability of SMPT that were objective tests as well as the reliability. The reliability test shows that the instrument was valid with the reliability coefficient of r = 0.87. The data were collected and analyzed using Statistical Packaged for Social Sciences (SPSS). The research questions were answered using descriptive statistics of mean and standard deviation. The formulated hypotheses were tested using Analysis of Covariance (ANCOVA). The ANCOVA were appropriate in order to ensure initial group differences were taken care of. The decision rule was: when the p-value is less than 0.05 ($P<0.05$), the null hypotheses will be rejected otherwise, the null hypotheses will be retained.

Presentation of results

Research Question 1: What are the pretest and posttest mean academic performance difference scores of senior secondary school students taught mathematics using reciprocal cooperative learning strategy and those taught using conventional method?

Table 1: Mean and Standard Deviation of Pretest and Post-test Scores of Students taught Mathematics with Reciprocal Cooperative Learning Strategy and those taught using Conventional Method

Teaching Methods	N	Pre-Test		Post-Test		Mean Difference
		Mean	S. D	Mean	S. D	
Reciprocal Cooperative Learning Strategy	83	25.88	10.08	38.84	10.06	13.18
Conventional method	89	24.00	10.18	25.66	9.02	

Table 1 presents the mean and standard deviation of the pretest and post-test scores of students taught mathematics using the reciprocal cooperative learning strategy and those taught using the conventional method. The results show that students taught with the reciprocal cooperative learning strategy had a pretest mean score of 25.88 (SD = 10.08) and a post-test mean score of 38.84 (SD = 10.06), resulting in a mean difference of 13.18. This indicates a substantial improvement in students' academic performance after being taught with the reciprocal cooperative learning strategy. On the other hand, students taught using the conventional method had a pretest mean score of 24.00 (SD = 10.18) and a post-test mean score of 25.66 (SD = 9.02), indicating only a slight improvement in performance. The results therefore suggest that students taught mathematics using the reciprocal cooperative learning strategy performed better in the post-test compared to those taught using the conventional method.

Research Question 2: What are the pretest and posttest mean academic performance difference scores between male and female secondary school students taught mathematics using reciprocal cooperative learning strategy?

Table 2: Mean and Standard Deviation of Pretest and Post-test Scores of Male and Female Students taught Mathematics with Reciprocal Cooperative Learning Strategy

Gender	N	Pre-Test		Post-Test		Mean Difference
		Mean	S. D	Mean	S. D	
Male	42	26.19	8.75	39.23	9.52	0.79
Female	41	25.56	11.38	38.44	10.69	

Table 2 presents the mean and standard deviation of pretest and post-test scores of male and female students taught mathematics using the reciprocal cooperative learning strategy. The results show that male students

had a pretest mean score of 26.19 (SD = 8.75) and a post-test mean score of 39.23 (SD = 9.52), while female students had a pretest mean score of 25.56 (SD = 11.38) and a post-test mean score of 38.44 (SD = 10.69). The mean difference between male and female students' post-test scores is 0.79, indicating that male students performed slightly higher than female students. However, the difference is very small, suggesting that both male and female students benefited almost equally from the reciprocal cooperative learning strategy in improving their academic performance in mathematics.

Hypothesis one

$H0_1$: There is no significant difference between pretest and posttest mean academic performance scores of senior secondary school students taught mathematics using reciprocal cooperative learning strategy and those taught using conventional method.

Table 3: Summary of ANCOVA Difference between the Academic Performance of Students in the Experimental and Control Groups

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	9571.325[a]	2	4785.663	60.553	.000	.417
Intercept	13410.262	1	13410.262	169.679	.000	.501
Pretest	2110.270	1	2110.270	26.701	.000	.136
Teaching methods	6681.355	1	6681.355	84.539	.000	.333
Error	13356.582	169	79.033			
Total	199312.000	172				
Corrected Total	22927.907	171				

a. R Squared = .417 (Adjusted R Squared = .411)

Table 3 presents the Analysis of Covariance (ANCOVA) results comparing the academic performance of students taught mathematics using the reciprocal cooperative learning strategy and those taught using the conventional method, while controlling for pretest scores. The F-value of 84.539 with a significance value of .000. This indicates that there is a statistically significant difference in the academic performance of students in the experimental and control groups. The partial eta squared value of .333 suggests a large effect size, meaning that the teaching method explains a substantial portion of the variance in students' academic performance. In addition, the pretest score is also significant F (1,169) = 84.539, P = .000, < 0.05 indicating that students' prior knowledge contributed significantly to their post-test performance. Therefore, the null hypothesis is rejected, implying that students taught with reciprocal cooperative learning strategy performed significantly better than those taught with the conventional method.

$H0_2$: There is no significant difference between pretest and posttest mean academic performance scores of male and female senior secondary school students taught mathematics using reciprocal cooperative learning strategy.

Table 4: Summary of ANCOVA of Difference between the Academic Performance of Male and Female Students in the Experimental

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2038.969[a]	2	1019.484	13.016	.000	.246
Intercept	7348.960	1	7348.960	93.827	.000	.540
Pre-test	2025.722	1	2025.722	25.863	.000	.244
Gender	4.946	1	4.946	.063	.802	.001
Error	6265.995	80	78.325			
Total	133536.000	83				
Corrected Total	8304.964	82				

a. R Squared = .246 (Adjusted R Squared = .227)

Table 4 presents the ANCOVA results examining the difference in academic performance between male and female students taught mathematics using reciprocal cooperative learning strategy while controlling for pretest scores. The results reveal that gender has an F-value of 0.063 with a significance value of .802, which is greater than the 0.05 level of significance. This indicates that there is no statistically significant difference between the academic performance of male and female students. The partial eta squared value of .001 shows a negligible effect size, meaning that gender has almost no influence on students' academic performance in this context, with significant F (1,80) = 0.063, P = 0.802, > 0.05 indicating that students' prior knowledge significantly influenced their academic performance. Therefore, the null hypothesis is retained, implying that reciprocal cooperative learning strategy benefits both male and female students equally in terms of academic performance.

Discussion of Results

The findings from this study reveals that those students taught using Reciprocal cooperative learning strategy had higher mean gain than those taught using conventional method. Specifically, the results from the tested hypotheses confirmed that there was significant difference in academic performance between the two groups, favoring the Reciprocal cooperative learning strategy. This improvement can be attributed to the unique learning opportunities provided by the Reciprocal cooperative learning strategy,

where students were grouped into 4-5persons per group, and class time was dedicated to discussion, collaboration, and engagement. The study agreed with previous findings of Ahmad and Zakariyya (2023) which established a significant improvement in the performance of students while partaking in Reciprocal cooperative learning strategy. The improvement in performance can also be attributed to features of Reciprocal cooperative learning strategy such as co-operation, reflection, and problem-solving skills among students. This finding buttressed the earlier finding of Ginga, Mohammed and Usman (2019) who found that the Reciprocal cooperative learning strategy was found more advantageous than a conventional approach.

The results from the hypotheses equally, reveals that there was no significant difference in the mean scores of male and female students taught mathematics using Reciprocal cooperative learning strategy. The Reciprocal cooperative learning strategy appeared to have a similar impact on the performance of both male and female students towards learning mathematics. The finding aligned with Adeyemi and Ojo (2021) who found no significant differences in the impact of the Reciprocal cooperative learning strategy on performance of male and female students. Similarly, Collins (2021), Ginga, Mohammed and Usman (2019) also found no significant differences in the mean scores of male and female students taught with Reciprocal cooperative learning strategy. The finding is contrary to that of Rabab'h, Veloo and Perumal, (2014) who concluded that female students performed better than their male counterpart in mathematics problem solving. The findings of Ajai and Imoko, (2015), and Usman and Musa (2015) that revealed male students' achievement in different areas of mathematics is higher than their male counterpart. The reasons for these different findings could be as the result of the study areas, population of the study, sample and sampling technique, and may be method of data analysis.

Conclusion

The study concluded that the Reciprocal cooperative learning strategy is an effective approach for improving the academic performance of student's in mathematics compared to conventional methods. Similarly, the Reciprocal cooperative learning strategy yielded significant gains in academic performance. This suggests that the active learning environment and personalized support provided by the Reciprocal cooperative learning strategy enhanced conceptual understanding and problem-solving skills.

It was also concluded that Reciprocal cooperative learning strategy was effective for both male and female students. However, the Reciprocal cooperative learning strategy emerges as a promising pedagogy for improving students' academic performance in mathematics, without inherent gender biases.

Recommendation

1. In-service training programs, seminars, work-shops and symposia should be organized by the federal and state governments to train mathematics teachers in the use of Reciprocal learning strategy in teaching mathematics.
2. Teachers should be encouraged to use Reciprocal learning strategy in teaching in order to improve students' academic performance irrespective of gender because Reciprocal learning strategy is a gender friendly teaching technique with regards to academic performance.

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