

EFFECT OF RECIPROCAL TEACHING STRATEGY ON STUDENTS' PERFORMANCE IN WORD PROBLEM LEADING TO SIMULTANEOUS EQUATIONS FOR CREATIVITY IN BASIC, SECONDARY AND TERTIARY EDUCATION IN YOBE STATE

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Abstract

The study investigated the effect of reciprocal teaching strategy on performance in Word problem leading to simultaneous equations for creativity in Basic, Secondary and Tertiary Education in Potiskum educational Zone Yobe State, Nigeria. The population of the study covered fifteen public senior secondary schools in Potiskum Educational Zone of Yobe State with total number of 5,543 students. Samples of four schools with a total number of 210 students' were selected using simple random sampling technique and participated in the study. In each school one intact class was randomly assigned to experimental or control groups. The study has two research objectives, answered two research questions and tested two null hypotheses at $p \leq 0.05$ level of significance. The study adopted quasi-experimental design involving pretest, posttest control group design. For the purpose of data collection, one instrument; Algebra Word Problem Performance Test (AWPPT) was used. The instrument was validated by experts and pilot tested with the reliability coefficient of 0.75 obtained using Pearson Product Moment Correlation Coefficient (PPMC). The hypotheses were tested using Independent sample t- test statistics and the results obtained from the analysis revealed that there was significant difference in performance in favour of students exposed to Reciprocal Teaching Strategy (RTS). The results further showed no significant difference in performance of male and female students when exposed to reciprocal teaching strategy. The study concludes that Reciprocal Teaching Strategy (RTS) is effective in enhancing students' performance and the strategy is gender friendly in terms of performance. Based on the findings of the study recommendations were made such as Curriculum planners and curriculum development bodies in Nigeria like NERDC should design programme that will incorporate the use of Reciprocal Teaching Strategy in teaching Mathematics at senior secondary school level.

Keywords: Algebra Word Problems, Performance, Reciprocal Teaching Strategy

Introduction

Mathematics is a subject that is found useful in most fields of study; hence it is a core subject for both primary and secondary schools students in Nigeria (Salman, 2003). Abakporo (2005) viewed mathematics as the queen and substances of science and technology. The formal education of any country especially Nigeria is primarily responsible for providing scientific and mathematics fundamental skills, and ways of thinking as well as developing value in science particularly mathematics. Korau (2007), viewed mathematics as the pivot on which any true science can rest and no science can succeed without going through mathematical demonstration. To highlights the intricate link of mathematics to science and technology Ale and Adetula (2010) opined that without the knowledge of mathematics there will be no science and without science there will be no technology and without technology there will be no modern society. Therefore, it serves as the only core or compulsory subject across the globe, because there is no nation of the world where Mathematics is not been taught but the language of instruction may differ due to the official language of each nation (Salman, Ayinla, Adeniyi, Ogundele, & Ameen, 2012).

Kurumeh, Jimin and Mohammed, (2012) described Mathematics as an essential tool for advancement of science and technology. No nation can develop scientifically and technologically if it neglects mathematics because it is a subject that enables a learner to have adequate

understanding and interpretation of concepts in science and technology. The roles that Mathematics plays make it to be recognized by the Federal Republic of Nigeria in her National Policy on Education (FRN, 2013) as a core subject that all students regardless of discipline, gender or ability must study and pass at credit level especially at secondary school level. To achieve the desired goal of teaching Mathematics, Nigeria as a developing country needs scientific innovation in teaching and learning process and as such requires mathematician that would enable the early and proper realization of these goals. Therefore, any short comings in this subject can cause setback to the achievement of science and technology objectives. In view of this, researchers recommended various methods that are applicable in teaching mathematics but research evidences revealed that many teachers used traditional teaching method which may be causes of students' poor academic performance in the subject.

Academic performance is the quality of students' scores in a test or examination when compare with that of others of the same level. It is the quality of students' result that is reflected in their test or examination. Adeyemi, (2008) viewed academic performance as the scholastic stand of a student at a given time. Musa (2010) viewed academic performance as the quality of result produced by student as reflected in the quality of their examination score. James, (2015) maintained that academic performance really involved knowing how much students has learned. In mathematics, students performed poorly in Nigerian schools over many years. Research evidences revealed that poor performance of students in mathematics is attributed to lack of teaching materials, mathematics phobia, teaching method, poor teaching facilities that include equipment and instructional materials for effective teaching. This study used reciprocal strategy to see if it can address the students' poor performance in mathematics.

Reciprocal Teaching Strategy (RTS) is a teaching strategy developed by Palincsar and Brown in 1984 for reading comprehension using four strategies of predicting, questioning, clarifying, and summarizing. These four cognitive reading comprehension strategies, through the reciprocal teaching approach, have also been applied to support students to comprehend and solve mathematical word problems. Reciprocal teaching is a cooperative learning instructional method in which natural dialogue models and reveals learners' thinking processes about a shared learning experience (Ojo, 2015). It is observed that Reciprocal teaching is an interactive instructional activity that takes place in the form of dialogue between teachers and students regarding segments of text. Researchers adapted reciprocal teaching approach for problem-solving in mathematics by including predicting, clarifying, solving and summarising as their key strategies or stages (Meyer, 2014).

Students were encouraged to predict the type of mathematical questions being asked, the mathematical operations required and what the answer might look like, using their prior knowledge, the structure of the text, including headings, illustrations/diagrams and problem content (Reilly, Parsons & Bortolot, 2009). During the clarifying stage, students listed words they were unfamiliar with, facts that they knew and information they had yet to determine to successfully solve the problem. Meyer, (2014) state that in the solving phase, students used a range of problem-solving strategies and demonstrated their working using pictures, diagrams, numbers or words. During the summarising stage, students engaged in self-reflection, including justifying their answer, reflecting on how they might refine their approach if presented with a similar problem, and evaluating how they contributed to the group problem-solving task. Studies using the reciprocal teaching approach to solve mathematical word problems, found that the students gained confidence when solving word problems and that both the teacher and the students found the approach useful when using a five-stage process applied to word problems focused on statistics (Quirk, 2010).

How to use reciprocal teaching in Mathematics

Reciprocal Teaching for Mathematics strategy is based on the model proposed by Palincsar and Brown but has a number of key adjustments with solving instead of questioning. Therefore, before Reciprocal Teaching can be used successfully by students, they need to have been taught and had time to practice the four strategies that are used in reciprocal teaching (predicting, clarifying solving and summarizing,). Teacher has to get students prepared to use reciprocal teaching through:

1. Put students in groups of four.
2. Distribute one note card to each member of the group identifying each person's unique role:
 - Predictor
 - Clarifier
 - Solver
 - Summarizer
3. Students have to read the question given. The teacher has to encourage them to use note-taking strategies such as selective underlining or sticky-notes to help them better prepare for their role in the discussion.
4. At the given stopping point, 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 and what their answer might look like.
5. The Clarifier will address words that are unfamiliar with, and states all the facts they know, that is generally statements from the mathematical problem.
6. The students are required to solve the problem using a number of problem solving options.
7. Summarizer is required to justify their answer and evaluate how they would refine the process if presented with a similar problem
8. The roles in the group then switch one person to the right, and the next selection is read. Students repeat the process using their new roles. This continues until the entire selection is read (Ejike, 2010)
9. Throughout the process, the teacher's role is to guide and nurture the students' ability to use the four strategies successfully within the small group. The teacher's support is gradually withdrawn as students develop skill,

To prove the application of reciprocal teaching in Mathematics Bjorn, Aunola and Nurmi, (2008) , Reilly, Parsons and Bortolot (2009), Huber (2010), Collen (2011), Ardiansyah. (2014) conducted researches on the effects of reciprocal teaching strategy on students' performance in mathematics word problems and the finding showed it enhanced students' performance. Also Segerby and Chronaki (2018) conducted a research on a topic Primary students' participation in mathematical reasoning: Coordinating reciprocal teaching and systemic functional linguistics to support reasoning in the Swedish context. The result showed that reciprocal teaching improved students' performance significantly. Research revealed that if this strategy is used in teaching, the students' performance in mathematics might be improved based on gender.

Gender is a set of characteristics distinguishing between male and female, particularly in the cases of men and women. Depending on the context, the discriminating characteristics vary from sex to social role to gender identity. Ekeh,(2000), Viewed gender as a socio-cultural construct that assigns roles, attitudes and values considered appropriate for each sex. Researches revealed that it is one of the factors that affect academic performance in mathematics. Mutemeri

and Mygweni (2005) are of the view that the idea that mathematics is for boys may result in low motivation in girls and could widen the gender gap in mathematics achievement in favor of boys. Researches conducted based on gender and academic performance in mathematics revealed varying views and findings; Awang and Ismail (2007), Hydea and Mertz (2009), Rabab'h, Veloo and Perumal, (2014) revealed that overall average achievement for female is higher than their male counterpart. But Gambari, Shittu and Taiwo (2013), Shafiq (2013), Ajai, Imoko, and O'kwu (2013), Josiah and Adejoke (2014), Saidu and Bunyamin (2016), Mutai, (2016), Obi, Agwgah, Newen & Nwoye, (2017) Tihamiyu, Salman and Issau, (2017) revealed no gender difference in the performance of male and students in different topics in mathematics. While Kyei, Apam and Nokoe, (2011), Atovigba, Okwu and Ijenkeli, (2012), Ajai & Imoko, (2015), Usman and Musa (2015) showed that male students performed better than their male counterpart.

Statement of the problem

Despite the crucial role mathematics play in science and technology, the performance of students in mathematics at the secondary school level in Nigeria is still below average. The low students' performance in mathematics has become a source of concern in mathematics education. Researchers identified many factors that attributed to this poor performance include; poor instructional method, poor students' background, lack of motivation, large class size, poor evaluation, lack of students' interest, unqualified teachers, poor syllabus coverage among others (Mohammed, 2015 & Ayuba, 2017). But the neglect of students centered learning and low students interest may be the major reasons for the poor performance of students in Mathematics at secondary school level. Teaching Mathematics especially at the secondary school level have overwhelmingly remain teachers-centered, with greater emphasis on lecture method and use of textbook rather than helping students to think critically across subject areas and applying the knowledge to real-life situations.

The poor performance of students in Mathematics may not be unconnected with the poor performance in algebra as reported by West African Examination Council Chief Examiner's Report, (2016) which revealed that most of the questions in words and worded problems most especially in algebra have been one of many students' weak areas for many years. The report further revealed that students were able to solve mathematical equations but unable to solve the same problem when put into statement form.

Objectives of the Study

The study has the following specific objectives:

1. To ascertain the effect of reciprocal teaching strategy on students' performance in algebra word problem.
2. To examine the effect of reciprocal teaching strategy on performance of male and female students in algebra word problem.

Research Questions

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

1. What is the difference in the mean performance of students taught algebra word problem using reciprocal teaching strategy and those taught using lecture method?
2. What is the difference in the mean performance of male and female students taught algebra word problem using reciprocal teaching strategy?

Null Hypotheses

The following null hypotheses were formulated and tested at $p \leq 0.05$ significant level.

HO₁: There is no significant difference in the mean performance score of SSII students taught algebra word problem using reciprocal teaching strategy and their counterparts taught using lecture method.

HO₂: There is no significant difference in the mean performance score of male and female SSII students taught algebra word problem using reciprocal teaching strategy

METHODOLOGY

Research Design

The study employed quasi experimental design involving pre-test, post-test and experimental and control groups. The experimental group was taught word problem leading to simultaneous equations using reciprocal teaching strategy while the control group was taught same concept using lecture method for the same period. However, before the treatment, the two groups was pre-tested on academic performance and students’ interest in algebra word problem to ensure they are equivalent in term of ability. After the treatment post-test was administered to determine students’ academic performance and interest in algebra word problem. The population of the study covered fifteen public senior secondary schools in Potiskum Educational Zone of Yobe State with total population of five thousand five hundred and forty three (5,543). In which a sample of two hundred and ten (210) students were selected using stratified sampling technique and were assigned to experimental and control groups stratified sampling technique was used because all the schools in the zone are not coeducation.

For the purpose of data collection, three experts validated instrument: Algebra Word Problem Performance Test (AWPPT) developed by the researchers was used. After pilottesting the instrument, the result was analysed using Pearson Product Movement Correlation Coefficient (PPMC) and the reliability coefficient obtained is (r=0.74

Data Analysis Procedure

The data collected was used to answer the research questions and test the hypotheses. All the research questions i and ii were be answered using mean and standard deviation. The null hypotheses were tested at $p \leq 0.05$ level of significant as follows;

Answers to Research Questions

Research Question one: What is the difference in the mean performance of students taught Algebra Word Problem using reciprocal teaching strategy and those taught using lecture method?

In order to answer this research question, a descriptive statistics of mean scores and standard deviation were used and presented in Table 1.1.

Table 1.1 Summary of Posttest Mean Scores of Academic Performance of Students in Experimental and Control Groups.

Group	N	Mean	SD	Mean gain
Experimental	117	24.65	4.667	4.59
Control	93	20.06	5.714	

Table 1.1 presents the descriptive statistic of means and standard deviations on performance scores for experimental and control groups. The mean performance score for experimental group (M=24.65, SD=4.667) was higher than that of control group (M=20.06, SD=5.714). The mean difference was 4.59 in favor of Experimental group.

Question Two: What is the difference in the mean performance of male and female students taught algebra word problem using reciprocal teaching strategy?

In order to answer this research question, a descriptive statistics of mean scores and standard deviation were used and presented in Table 1.2

Table 1.2: Means and Standard Deviations of Academic Performance of Posttest Scores of Male and Female Students taught algebra word problems using Reciprocal Teaching Strategy

Variables	N	Mean	SD	Mean Difference
Male	57	24.07	4.114	1.13
Female	60	25.20	4.172	

Table 1.2 presents the descriptive statistic of means and standard deviations on performance scores for male and female students. The mean performance score for male students (M=24.07, SD=4.114) was higher than that of female students (M=25.20, SD=4.172). The mean difference was 1.13 in favor of female students.

Testing of the Null Hypotheses

The null hypotheses formulated were tested at 0.05 level of significant using inferential statistic as follows:

HO₁: There is no significant difference in the mean performance score of SSII students taught algebra word problem using reciprocal teaching strategy and their counterparts taught using lecture method t-test analysis was used to test null hypothesis 1 using data of post test scores of students in experimental and control groups. The result of the analysis is presented in Table 1.3

Table 1.3: Summary of t-test Analysis of Posttest Scores of Students in Experimental and Control Groups

Groups	N	Mean	SD	Df	T	P	Decision
Experimental	117	24.65	4.667				
				208	6.401	0.001	Sig
Control	93	20.06	5.714				

Table 1.3 results, shows that the t-value computed is 6.401 and the p-value of 0.001 is observed at degree of freedom of 208. Since the critical p-value of 0.001 is less than the alpha value of 0.05, there is a significant difference in the academic performance of the subjects in experimental and control groups. The significant difference is in favor of experimental group as revealed in their mean scores. A significant difference implies rejection of null hypothesis. Consequently, the null hypothesis that states that there is no significant difference in the academic performance scores of students taught algebra word problems using reciprocal teaching strategy and their counterpart taught the same concept using lecture method is hereby rejected.

HO₂: There is no significant difference in the mean performance score of male and female SSII students taught algebra word problem using reciprocal teaching strategy Posttest scores of the male and female students in experimental group were used. The independent t-test statistics was also used in data analysis. The detail is presented in Table 1.4

Table 1.4: Summary of t-test Analysis of Posttest Scores of Male and Female Students in Experimental Group only

Variables	N	Mean	SD	Df	T	P	Decision
Male	57	24.07	4.644				
				115	1.313	0.192	Not Sig
Female	60	25.20	4.661				

Table 1.4 results, shows that the t-value computed is 1.313 and the p-value of 0.192 is observed at degree of freedom of 115. This shows no significant difference between males and female performance exposed to reciprocal teaching strategy in the posttest treatment, since statistically P of value 0.192 is greater than the alpha of 0.05. This showed that males and females performance in algebra word problem was not significantly different. Therefore the null hypothesis which state that there is no significant difference in the mean performance score of male and female SSII students taught algebra word problem using reciprocal teaching strategy is hereby retained.

4.3 Major Findings

From the results presented in this study, the summary of the major findings are:

1. There is significant difference between the academic performance scores of students taught algebra word problems using Reciprocal Teaching Strategy and those taught using lecture method. Students in the experimental group performed better than control group.
2. There is no significant difference in the academic performance of male and female students exposed to Reciprocal Teaching Strategy.

Discussion of Results

This study investigated the study effect of reciprocal teaching strategy on students' interest and performance in algebra word problem among senior secondary in Potiskum educational Zone Yobe State, Nigeria. To achieve this aim, students in the experimental group were taught algebra word problems concepts using the reciprocal teaching strategy while students in the control group were taught the same concepts using lecture method.

Finding the study reveals that experimental group recorded the highest mean score than control group, which shows that there is a significant difference in the academic performance of the subjects in experimental, and control group. The significant difference implies rejection of null hypothesis and retaining alternate hypothesis. Therefore, null hypothesis that states that there is no significant difference in the mean performance score of SSII students taught algebra word problem using reciprocal teaching strategy and their counterparts taught using lecture method is rejected. The significant difference indicates that students in experimental group recorded the highest mean score than those in the lecture method. This finding supports that of Bjorn, Aunola and Nurmi, (2008), Reilly, Parsons and Bortolot (2009) and Meyer, (2010) who revealed that reciprocal teaching enhanced students' performance in Mathematics word problems.

The findings of this study also are in agreement with findings of Quirk, (2010) who focused on the use of reciprocal teaching strategy when solving Mathematics word problems and found out that there was significant difference in the performance of students taught Mathematics word problems using reciprocal teaching strategy and those taught using lecture method. The findings are also in conformity with that of Huber (2010) who investigated the Impact of Reciprocal Teaching on Mathematics Problem Solving for Grade 4 Students and opined that reciprocal teaching strategy improve the performance of students in mathematics problem solving skills and also supports that of Ardiansyah (2014) Meyer (2014), Kim and Kasmer (2015) and Segerby and Chronaki (2018) who added that reciprocal teaching improved students' performance significantly. But the finding contradict that of Collen (2011) who conducted a research on Fifth

Grade Children's Use of Reciprocal Teaching to Solve Word Problems in Mathematics and found that there is no significant difference for overall posttest outcomes.

Findings also revealed that no significant difference in the performance of male and female students when exposed to reciprocal teaching strategy. This showed that the strategy is gender friendly in terms of performance. This is in harmony with the findings of Yusuf and Afolabi, (2010) and Gambari, Shittu and Taiwo (2013) that revealed no significant different in the performance of male and female students in algebra. It is also consistent with the findings of Shafiq (2013) who carried out a research on the effects of gender on algebra, geometry, and trigonometry performance and found no gender different in the overall students' performance. The finding further supports that of Ajai, Imoko, and O'kwu (2013), Josiah and Adejoke (2014) and Saidu and Bunyamin (2016). Research evidences like that of Mutai, (2016), Obi, Agwgah, Newen and Nwoye, (2017) and Tihamiyu, Salman and Issau, (2017) also ascertained that no gender friend in students' performance in Mathematics

But the findings in this study is inconformity with that of Awang and Ismail (2007) who examines gender differences in terms of the overall mathematics average achievement in the main content areas of mathematics topics, which include; fraction and number base, data representation, analysis , probability; geometry and algebra and found that female students performed better than their male counterpart. It 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 further did not support that of Kyei, Apam and Nokoe, (2011), Atovigba, Okwu and Ijenkeli, (2012), (Ajai & Imoko, (2015), and Usman and Musa (2015) that revealed male students' achievement in different areas of Mathematics is higher than their male counterpart.

Conclusion

Based on the findings of this study, it is concluded that students taught algebraic word problems using Reciprocal Teaching Strategy performed better academically than their counterpart taught same concept using lecture method. Also academic performance of male and female students is not different when exposed to Reciprocal Teaching Strategy which means this strategy is gender friendly in terms of performance.

5.4 Recommendations

In this study, some recommendations were made based on the findings and conclusions. They are as follows.

- 1 The study revealed that Reciprocal Teaching Strategy enhances students' performance in Mathematics especially algebra word problems. Therefore, education stake holders such as Federal Ministry of Education, State Ministries of Education; NERDC among others should be encouraged the use of this teaching strategy at senior secondary school level which can be done through periodic seminars and workshops for teachers on how to use RTS.
- 2 Curriculum planners and curriculum development bodies in Nigeria like NERDC should design a programme that will incorporate the use of Reciprocal Teaching Strategy in teaching Mathematics at senior secondary school level.

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